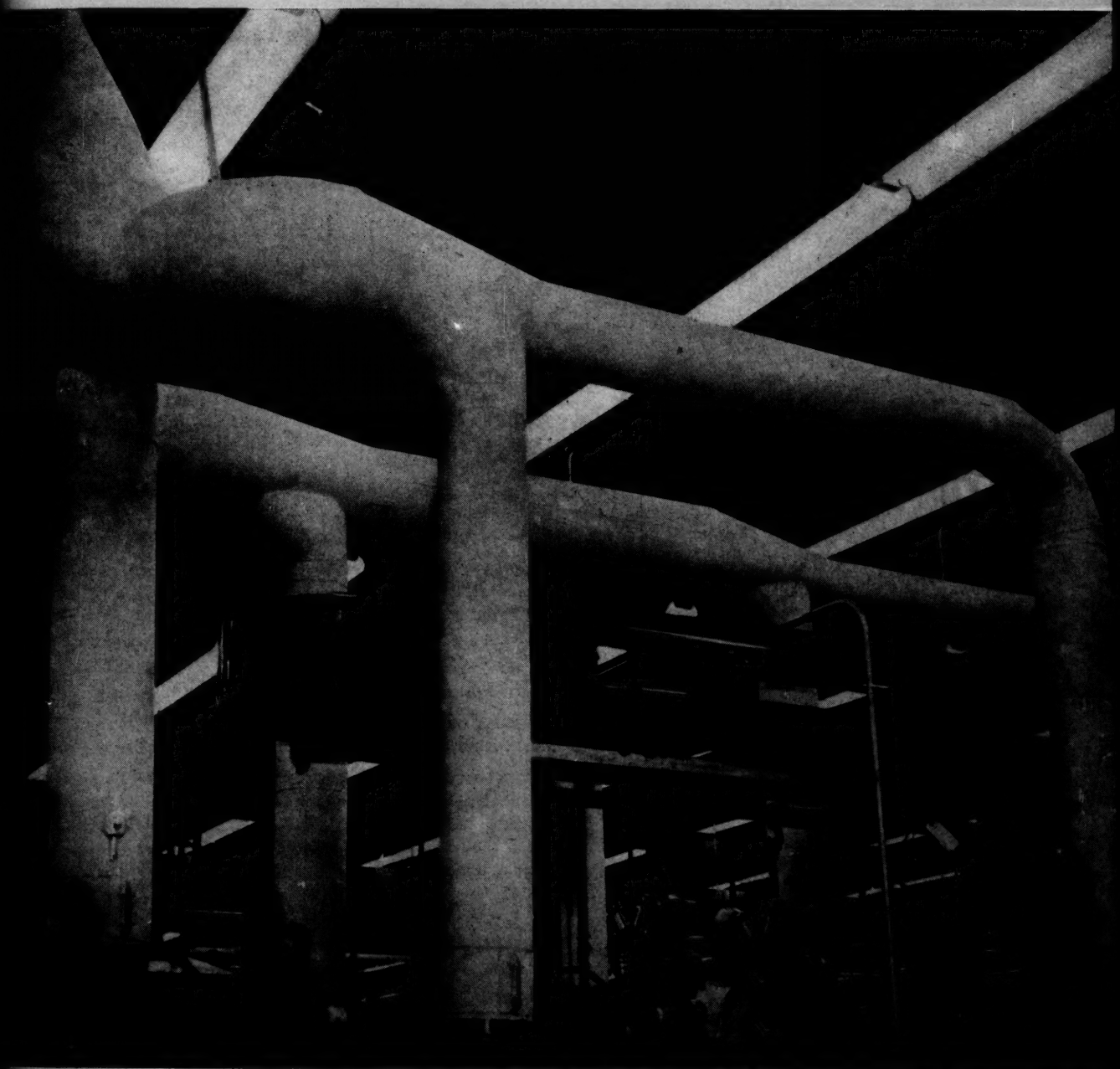
MAY, 1952

HEATING AND VENTILATING

CLUDING AIR CONDITIONING – PIPING – REFRIGERATION – AIR SANITATION



Part of the Plating Exhaust System Serving Chrysler's New Engine Plant. See Page 3.

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Snow Melting System Design . . Page 83

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"HET UP" about YOUR wasteful heating SET UP?

Why not change to

THERMOLIER

UNIT HEATERS

If you're dismayed about *last winter's* high-cost-of-heating, how about next year — when it may be as hard to get *fuel*, as it was for you to get *heat* this year?

Here's a red-hot tip. To save heat and fuel, install Thermolier Unit Heaters. But don't delay. Material shortages can seriously disrupt the production of unit heaters. In addition, skilled men are available to make installations now. They may not be in the days ahead. Study these Thermolier Unit Heater advantages — *and act promptly.*

HEATING COMFORT Thermoliers provide quick heating from a cold start. Desired room temperatures are easily maintained within a close range.

LOW FIRST COST Thermoliers are so efficient and so compact that their heating capacity is often equivalent to the capacity of cast iron radiation or pipe coils of twice the cost.

ECONOMY OF OPERATION Heat is forced down to the working level . . . not banked uselessly at the ceiling level.

ADAPTABILITY TO EQUIPMENT AND FLOOR LAYOUT Thermolier unit heating is widely used in industrial plants and warehouses, garages, stores and public buildings. The units and the simple piping are overhead where they do not interfere with arrangement of the operating machinery or equipment.

THERMOLIER CONSTRUCTION FEATURES THAT SAVE MONEY

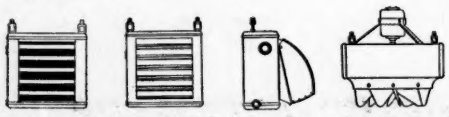
Use of plain thermostatic trap, the simplest and least expensive kind of trap, is practical because of Thermolier's exclusive internal cooling leg.

Maximum capacity provided at all times and annoying, destructive water hammer eliminated by built-in pitch of tubes and internal cooling leg which assures continuous drainage of condensate.

Damaging strains caused by expansion and contraction eliminated by "U" type expansion tubes.

Safety and durability assured with leak-proof tube-to-header construction.

Eight other important features. Write for Thermolier Catalog.



Horizontal Delivery | Textile Model | Velocity Nozzle | Vertical Delivery

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WHENEVER PIPING IS INVOLVED

GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach • Los Angeles • Milwaukee • Minneapolis • New York Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

HOT JOBS call for COOL HELP!

Pouring liquid steel into ingot moulds at a temperature of 2800° F. is a hot job that demands skill and constant attention. When workmen are exposed to such intense heat, thermotic fatigue can be a real problem.

At Colorado Fuel and Iron Corporation's mill in Pueblo, Colorado, they solved the problem by mounting a DeBothezat "Hy-V" Air Jet on the cab of the crane which handles the ladle, so that the fan unit travels right with the men as they work. "Hy-V" Air Jets project a concentrated stream of fresh air as far as 35 feet, without the use of ducts, to keep workers comfortably cool, alert and efficient.

DeBOTHEZAT "HY-V" AIR JET is a 14-blade axial-flow pressure fan in a nozzle-shaped housing. It can be furnished with a bracket for wall installation or it can be mounted on a portable wheeled stand. Both types are available with fan wheels from 18" to 30" in diameter, with capacities up to 12,000 CFM.

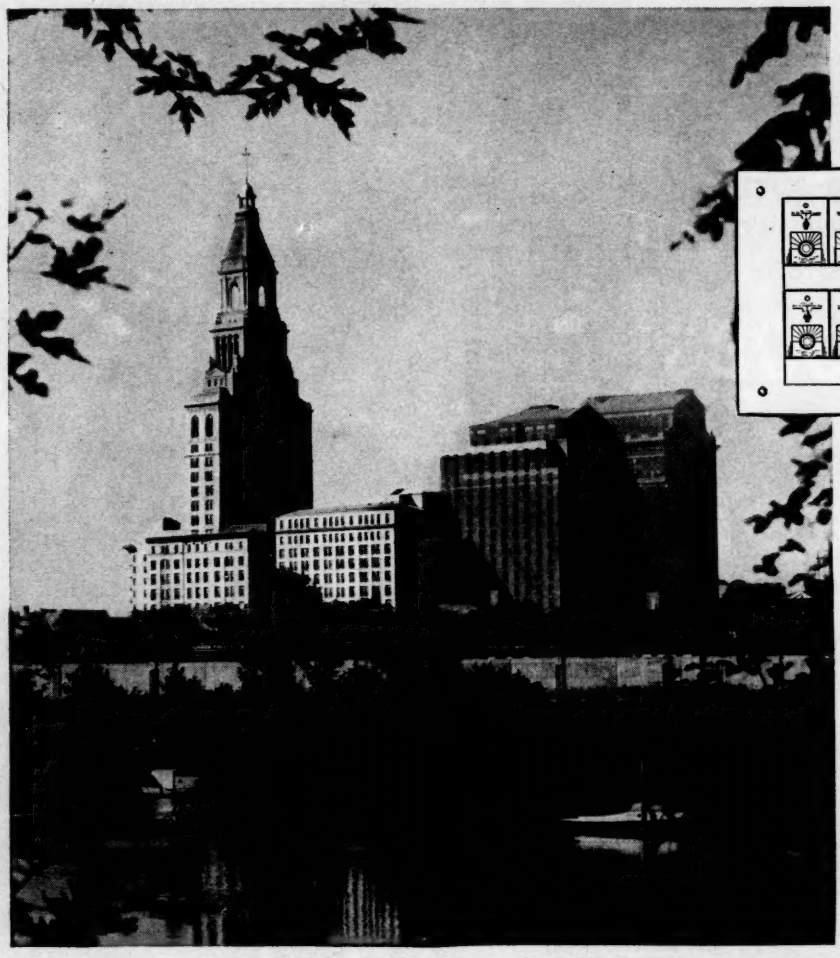
Ask your DeBothezat Fans representative or write the factory today for a bulletin on "Hy-V" Air Jets. Address Dept. HV552.

Certified Ratings

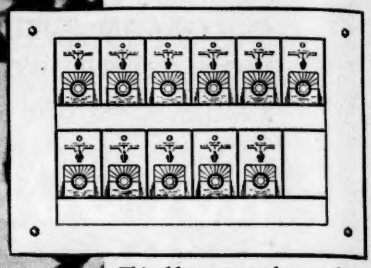
AMA

DeBothezat Fans

Division of American Machine and Metals, Inc.
EAST MOLINE, ILLINOIS



The Travelers Insurance Co. Buildings, Hartford, Conn. Architects: Voorhees, Walker, Foley & Smith. Consulting Engineers: Meyer, Strong and Jones. Heating Contractor: Libby and Blinn, Inc.



This 11-zone panel centralizes control at one point. Any zone may be (a) shut off, (b) put on automatic or (c) put in heating-up position from this point. Rate of heat to any zone may be speeded up or slowed down in comparison with the normal supply as indicated by Outdoor Thermostat control.

Heating Modernization Program Pays The Travelers Insurance Company

The original home office building of The Travelers Insurance Company was built in 1906. As The Travelers grew, additional office space was provided by new buildings erected in 1912, 1918 (the Tower building), 1921 (the building in center foreground), 1926, 1928 (the large rectangular building at right), 1938 and 1939, bringing the total floor area occupied by the Company to 1,012,834 square feet.

In 1944, 38 years after the original heating installation, The Travelers asked their architects to recommend the changes necessary for modern heating with two objectives—minimum fuel cost and complete comfort for all employees.

After careful study, the following were approved: (1) four new oil-fired water-tube boilers with automatic combustion control, each boiler having a capacity of 25,000 lbs. of steam per hour, (2) a smaller water-tube boiler for heating domestic hot water in the summer months, new vacuum pumps and related boiler-room equipment, (3) improvements to the existing ventilation system, (4) a Webster Moderator System of Steam Heating for "Controlled-by-the-Weather" economy.

By 1948, when the modernization program was completed, heating service was noticeably improved. Employee comfort was definitely improved as chronic heating complaints had been eliminated. Labor costs were reduced.

Actual fuel savings of approximately 40% were indicated by a comparison of heating costs between the operation of the old coal fired plant and heating system, and the new boiler plant along with the new Moderator controlled heating of the buildings.

Here is evidence that well-planned heating modernization programs pay big dividends in improved heating service and lower fuel costs. If you are planning the heating for a new building or modernization of an existing building, the Webster Moderator System belongs in your plans.

There are Webster representatives in 65 principal cities working with architects, engineers and heating contractors in the application of Webster Systems and Equipment. Call your Webster representative or write us for his name.

Address Dept. HV-5

WARREN WEBSTER & CO.

Camden 5, N.J. Representatives in Principal Cities

In Canada, Darling Brothers, Limited, Montreal

WEBSTER MODERATOR SYSTEM OF STEAM HEATING

"Controlled by the weather"

HEATING AND VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH THE DESIGN AND APPLICATION OF AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION IN BUILDINGS

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The Industrial Press

Also Publishers of
HEATING & PLUMBING EQUIPMENT NEWS
and technical books.

THIS MONTH'S COVER

In the new engine plant of Chrysler Corp., at Trenton, Mich., aluminum pistons are immersed in ten separate baths and rinses as part of a tin plating process. The cover photograph shows some of the exhaust lines to carry off the fumes from the various plating process baths. Photo, courtesy of Chrysler Corp.

Washington News

LORING F. OVERMAN

IN RECORDING news events of the last 30 days, it is quite likely that the steel crisis will be ranked of first importance, with the Mid-West floods scoring a close second.

It is possible, however, that the memory of both of those happenings will have faded away long before the heating, ventilating, plumbing, and air-conditioning industries have felt the full effects of one Washington trend which was reported without causing much of a ripple in the Capital city.

The news, coming from the Census Bureau, contained information startling only to market analysts—those who point the way toward business opportunities of the future. In general, the data consisted of projections of state, regional, and national population changes through 1960. The projections, based on low, high, and medium estimates of population changes, show where to look for what types of installations during the next eight years.

Westward, Ho!

The projections generally show a continuation of trends evident during the 1940's, with population centers drifting westward. Based upon median estimates, the fastest-growing region will continue to be the Pacific Coast, where a rise of 30.3% is anticipated during the 10 years, 1950-60. In contrast, the national gain is to be only 11.7%. Mountain states are slated to rise 16.7%, and the South Atlantic 14.3%. Other regions are expected to show gains smaller than the U.S. average.

The estimates are based upon an expected increase of 17,699,000 in the period 1950-60, of which more than 10 million will occur between 1950 and 1955, and 7.6 million during the last half of the decade. Growth during the 1950-60 period is expected to be about 2 million less than during the preceding 10 years.

For firms and individuals who are planning where to market their products—and therefore, how to design products that will meet the public need—the Census Bureau figures make interesting reading.

Among individual states slated for interesting changes, California population is estimated to rise 33.2%, Arizona 29.0, Nevada 27.8, Oregon 24.9, Washington 20.9, New Mexico 20.3, Utah 18.1, Maryland 17.7, Michigan 15.2, Delaware 14.6, Colorado 13.7, and Texas 13.6%.

Slowest-growing areas are West North Central with a rise of 4.1%; New England and East South Central, each 7.6%; Middle Atlantic 8.0%; West South Central 9.6%. Lagging furthest behind are to be the Dakotas, Oklahoma, Nebraska, Arkansas, Vermont, and Iowa.

State Rank Changes

California, in fourth place in 1950, is to move to second in 1960—more than doubling its population between 1940 and 1960. Pennsylvania will drop from second to third place, Indiana moving up from 12th to 11th, displacing Missouri. Virginia moved from 19th in 1940 to 16th in 1950 and is to jump two more spaces by 1960. Florida made a sharp advance from 25th in 1940 to 20th in 1950, and is to go to 16th in 1960.

The foregoing estimates, available in a detailed report upon request to the Census Bureau, U. S. Department of Commerce, Washington 25, D. C., provides a lot of food for thought on the part of those planning and designing the heating and ventilating equipment of tomorrow. The projections paint a picture of where and whether the demand is to be for school construction or institutions geriatric; whether the market is to be heated or cooled, or whether the long range planning is to involve individual homes or multiple residences.

Also hidden in the report for those who like to delve deeply, are bases for many additional projections. Population movements, for example, involve new community facilities, theaters, schools, colleges, hospitals, stores and the like. Yes, the new Census Bureau Population Projection represents a welcome crystal ball for those who seek to read the future in terms of peaceful pursuits.

Construction Approved

Meanwhile a not-so-cold war continues, with the National Production Authority still keeping its hand on the construction industry. In completing the processing of second quarter construction applications, NPA approved 1,599 commercial projects estimated to cost $726,000,000. Included were 1,250 new starts; 310 already under way, and 39 requiring no controlled materials. NPA also deferred approximately 350 applications involving estimates of $160 million. Another 182 applications involving some $19 million were exempt, requiring only small amounts of materials which can be self-certified.

As forecast by the Census Bureau projection previously discussed, California was up front with 254 projects costing $146 million. New York was second with 156 projects costing more than $118 million.

By type of construction, churches topped the list of 45 categories with 638 projects to cost $142 million. Next came 84 office and loft buildings costing more than $133 million; then retail stores with 161 projects costing some $78 million. Others high on the list were banks, warehouses, gymnasiums, institutional buildings, public buildings, hotels, motels, assembly buildings, etc. Theaters and amusement construction was still on the deferred list, but if supply and labor conditions continue as at present, further suspension of the construction bans is likely.

Steel Controls Eyed

Relaxation of control over specified forms of steel during the fourth quarter of this year is also quite likely. Interestingly enough, Defense Production Administration people are quoted as indicating that the method of suspension or relaxation is a major problem—inferring perhaps that the question of supply is not seriously involved.

As an observation in point, there are some who contend that much of the vast expansion of steel production facilities has been directed too much toward production

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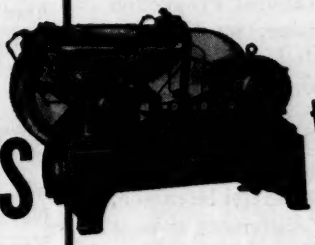
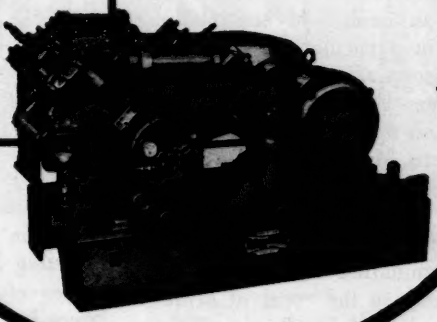
the performance you depend on



the economy you want



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Three reasons "Brunner Quotes" get you orders!

PERFORMANCE that you get only with units that are soundly engineered, rugged, and precision manufactured. Slow-speed "open type" compressors, extra deep cylinder cooling fins, fan type flywheels, oversize condensers and a score of other Brunner features that reflect constant engineering research and years of proven success.

ECONOMY that is recognized by thousands of users of commercial and industrial refrigeration and air conditioning. Men who watch operating and maintenance costs are Brunner's strongest boosters.

SIZES designed to fulfill your customers' needs from the air conditioning of large buildings, to holding meat at sub-zero temperatures, or keeping beverages cool. Sixty-nine air and water cooled models—¼ hp. to 75 hp.—for single or multiple unit installations.

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The new illustrated Brunner catalog gives you easy-to-use application data for determining the equipment you need for low cost, high efficiency air conditioning and refrigeration. But that's only part of the story. Why not get details of the Brunner proposition now? Write, wire or phone us today.

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BRUNNER MANUFACTURING CO., UTICA 1, NEW YORK, U. S. A.

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AIR CONDITIONING
Self Contained Units to 10 hp.
For remote installation...Brunner Condensing Units to 75 hp.

REFRIGERATION
Condensing Units from ¼ hp. to 75 hp. 69 Air and Water Cooled Models.

AIR COMPRESSORS
Single stage ¼ hp. to 2 hp. Two stage 1½ hp. to 15 hp. Horizontal and Vertical Models.

of sheet and strip. "What", they ask, "does the military need with so much sheet and strip?" They then proceed to total up all of the sheet and strip tonnage which the military or defense-supporting industries might reasonably be expected to use—even in a hot war—and come up with a surplus which should be tremendously interesting to the producers of heating, ventilating and air conditioning equipment, stoves, refrigerators and many other consumer items.

One method of relaxing controls, as suggested by William C. Truppner, chief of the National Production Authority's Production Control Division, would be to open-end CMP. This would permit steel mills to sell in the open market any steel of a given form and shape which might be left after all CMP-ticketed orders had been filled. Another way would be to increase self-certification limits and to raise the advance allotments to 100% of requests. The latter method would not be chosen, it was indicated, unless the agency had more than a reasonable chance of making such allotments good.

Commenting on the controls outlook, Defense Production Administrator Manly Fleischman indicated that there is little likelihood of an ending of controls in general, and copper controls in particular. "I don't believe that the worst is over in copper," he said. "Military requirements for copper remain very high, and unlike aluminum and steel, there is no appreciable increase in supply." Even for the latter items, Mr. Fleischman wanted it made clear that he was speaking of relaxation rather than decontrol.

An important task still facing the agencies, Mr. Fleischman said, is the determination of any possible shortages in production capacity in the event of actual war. A current problem, he indicated involves facilities for making heavy castings and forgings needed in a new "press program". That program, previously discussed in this column, contemplates the production of several presses of 35,000 tons and larger, to stamp out plane assemblies which now involve countless riveting operations.

Pipe Lines Certified

Although the defense "facilities program" is reported to be 52% in place, the Defense Production Administration is still granting certificates of necessity at a fast pace for the construction of new production units. At presstime, figures for the most recent week revealed 564 certificates of necessity for new or expanded facilities involving proposed costs of $792,758,000. Of the total, 186 were for small plans involving expenditures of $100,000 or less.

Largest certificates on the list were for oil and gas pipe lines. Topping the list was a certificate issued to the Trunkline Gas Co., Houston, Texas, for proposed investment of $80,000,000. Second largest on the list was issued to the Plantation Pipe Line Company, Atlanta, Ga., for pipe line construction to cost $51,700,000.

Other large certificates for pipe lines were: West Texas Gulf Pipe Line Co., Pittsburgh, Pa., $39,652,250; Sheel Pipe Line Corporation, Houston, Texas, $35,990,000; Panhandle Eastern Pipe Line Co., Kansas City, Mo., $30,860,000; Southern Natural Gas Co., Birmingham, Ala., $22,626,400; Texas Pipe Line Co., Terrebonne Parish, La., $19,054,643; Phillips Pipe Line Co., Bartlesville, Okla., $18,976,353.

3,573 Projects

How the oil and gas industry has fared under the defense program is further evidenced by a recent report issued by the Petroleum Administration for Defense. Applications for priorities assistance in completing or constructing of 3,573 projects were approved by PAD from June 13, 1951 through March 28, 1952. Projects have a total value of $3,516,961,284. Two hundred eighty two projects are under review, involving projects valued at $1,121,689,139.

Washington Miscellany

Test Center—Full scale testing of large marine boilers will be made possible by a $3,500,000 expansion to the Naval boiler and turbine laboratory at the Philadelphia Naval Shipyard.

Mechanical stokers—February factory sales of 1,260 mechanical stokers were 15% under 1,488 units in January and 25% below 1,680 in February, 1951, according to Census Bureau reports Series: M51B-22. All sizes of stokers except larger industrial showed declines from the January level. The following factory sales were reported for February: residential, 903 units; small commercial, 120 units; medium sized commercial, 122 units at 5,721 horsepower; small industrial, 58 units at 7,104 horsepower. Large industrial stokers increased from 38 to 57 in numbers and 29,843 to 50,351 in horsepower.

Heating Equipment—February shipments of most major types of heating and cooking equipment, non-electric, were below the January level, according to the Census Bureau. The only increase were floor and wall furnaces and domestic cooking stoves, which rose to 29,681 and 187,505 units respectively. February totals showed a 10% decrease for cast-iron boilers, 10,211,000 lbs.; cast-iron radiators, 2,226,000 sq. ft.; and oil burners, 45,748 units. Smaller declines were: warm-air furnaces, 48,529 units; water heaters, 167,335 units; and domestic heating stoves, 144,462 units. Inventories decreased in February for water heaters and floor and wall furnaces.

Synthetic Fuel—An independent company's survey of Bureau of Mines estimates shows that the various chemical co-products resulting from coal hydrogenation, with the exception of m-p-cresol, could be effectively marketed by 1955 at prevailing prices. The survey involved hypothetical locations at Rock Springs, Wyo., and Union County, Ky. The studies reduced the Bureau's figures for total capital investment from $414,440,000 to $403,827,000 in the case of Wyoming, and from $404,120,000 to $395,987,000 for the Kentucky project. Copies of the report may be secured by writing the Division of Information, Interior Building, Washington 25, D. C.

Gas Ban Modified—The Petroleum Administration for Defense has modified Gas Limitation Order No. 2 to permit two Michigan natural gas companies and one in New York to expand natural gas service. At Jackson, Mich., permission was given to serve 15,000 new house-heating customers during the next 12 months. At Coldwater, Mich., permission was given to serve a milling company, and at Syracuse, an insulator company was permitted to accept service.

IT TAKES ONLY ONE

to install pipe

but FIVE to repair

One of the most convincing demonstrations on the economy of using *durable* material is a repair job where low-first-cost material has failed—and is being replaced.

The original installation had been quickly made by pipe fitters. But the replacement calls for hours of work by as many as five crafts: pipe fitter, mason, plasterer, carpenter, painter. And this is only part of the cost story. The loss in production or utilization during the shut-down may amount to far more than the maintenance charge.

True, you pay a little more to *begin* with for Byers Wrought Iron pipe . . . but you pay a lot less to *end* with. In literally thousands of applications where corrosion costs you more than wrought iron, the use of this material is the soundest kind of economy move.

WHY WROUGHT IRON LASTS

This notch-fracture test specimen illustrates the unusual fibrous structure of wrought iron—which is responsible for the unusual corrosion resistance of the material. Tiny threads of glass-like silicate slag, distributed through the body of high-purity iron, halt and disperse corrosive attack, and discourage pitting and penetration. They also anchor the initial protective scale, which shields the underlying metal.

You will find a lot of helpful information on the control of excessive maintenance through the use of Byers Wrought Iron pipe in our technical bulletin, WROUGHT IRON FOR PIPING SYSTEMS. We will be glad to send you a copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco, Export Division: New York, New York.

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CORROSION COSTS YOU MORE THAN WROUGHT IRON

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TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

. . . and for temperature control, I'll insist on Honeywell!

Looks like the budding engineer in Steig's cartoon wants to be sure his "make-believe" building is going to be comfortable! For, as many heating engineers and contractors know, he realizes the *surest* way to make any building comfortable is to insist on Honeywell controls.

If *you* have a control problem, Honeywell can help you solve it. We can provide the proper thermal environment for any client—anywhere—in any kind of structure.

A large staff of well-informed control engineers—in 91 different Honeywell offices across the nation—are experienced in doing just that. Or—there's a lot of literature that's yours for the asking—on the automatic control of heating, ventilating and air conditioning.

So, why not *talk to Honeywell?* Why not *write to Honeywell* about *your* control problem?

Honeywell controls are available for all buildings—large, small, commercial or residential. See the facing page for interesting facts about some of these fine Honeywell controls.

H HONEYWELL

For help with any control problem talk to Honeywell

for offices, stores, restaurants, laboratories

Specify Honeywell Electronic Air Conditioning Control

Give your clients the ultimate in comfort—and increased efficiency, lower maintenance costs

Now, with this completely new type of air conditioning control, you can offer clients comfort and operating efficiency never before possible!

You see, this new Honeywell system electronically "feels" temperature changes as they occur and then gives *fast,* accurate modulating control over heating and air conditioning dampers or valves.

And because it is *electronic,* it's 100 times more sensitive than conventional systems! This means faster reaction to changes in load; no temperature "overshoot"; no waste of either warm or cool air.

It *allows new methods of operation* so equipment can be utilized at *peak* efficiency at all times! For example, change-over from heating, ventilating and cooling is accomplished smoothly without "jumps" in the control point. Its *flexibility* allows selection of the most economical sequencing of valves and dampers. And the *simplicity* of Honeywell's electronic thermostat cuts maintenance costs to a bare minimum.

Your selection of this new Honeywell *electronic* air conditioning control is sure to produce greater client satisfaction, once they experience its wonderful comfort and low maintenance costs!

MINNEAPOLIS **Honeywell**

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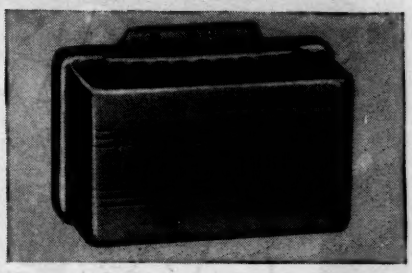
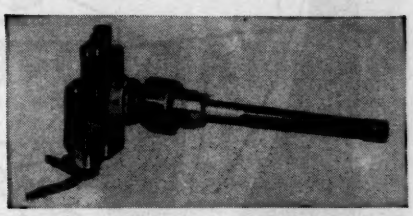
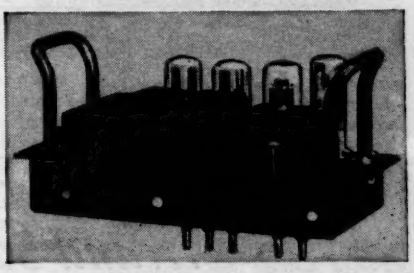
First in Controls



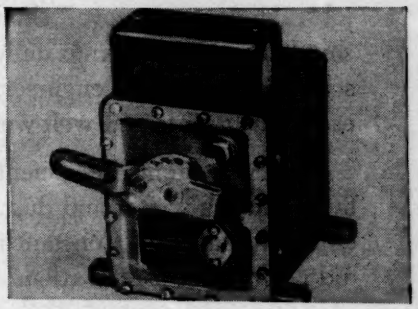
Room Thermostat. *No moving parts to wear out or get out of adjustment.*



Duct and Immersion Thermostat. *Measures temperatures accurately from -50 degrees to 300 degrees F.*



Electronic Relay. *Here's the famous "brain" that measures thermostat signals, operates the valves and dampers.*



Modulating Motor. *Slightest temperature fluctuation causes motor to change valves or dampers.*

... and for help with the temperature control, I'll talk to {your firm name}

FREE—personalized cartoon. For your 8½" x 9" reproduction of this Steig cartoon (incorporating your name or the name of your firm), fill out and mail coupon today.

MINNEAPOLIS-HONEYWELL REGULATOR CO.
Dept. HV-5-116, Minneapolis 8, Minnesota
Gentlemen:

☐ **Please send me your booklet "New Horizons of Comfort with Honeywell Electronic Air Conditioning Control."**

☐ **Please send me a free personalized reproduction of the Steig cartoon,**

inscribed with following name_____

Name_____

Firm Name_____

Address_____

City_____ **Zone**____ **State**_____

"The Printer Was Furious ...and So Was the Engineer!"

"Dirt in your building* is ruining my printing jobs. I'm going to move!" shouted the printer. "I smudge several drawings daily for the same reason!" exclaimed the engineer. Both firms were excellent tenants and well worth saving.

What was wrong? Inefficient air filters allowed fly ash in the winter and dust in the summer to enter the building. Constant filter maintenance did not correct the situation.

Farr Engineers recommended installation of a Size 56 Self-Washing FAR-AIR** unit to replace the ordinary filters and to handle the required 36,000 cfm. This unit was set to automatically wash and re-oil itself every three days. The installation completely eliminated the problem along with 90% of the maintenance. Result? Two happy tenants!

There are filters in the FAR-AIR line which will effectively solve your air filtration problems. Write today for information to: Farr Company, P.O. Box 10187 Airport Station, Los Angeles 45, California.

*Name furnished on request

FAR-AIR FILTERS

"Better by Farr"

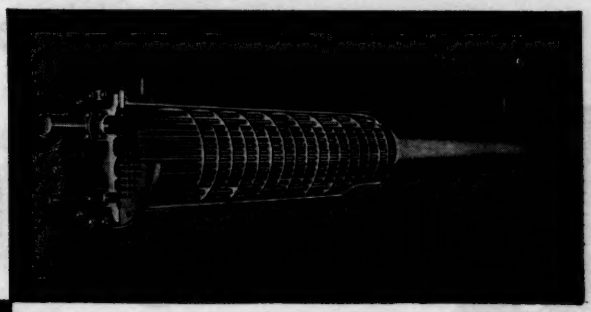
**Trade Mark Reg.

FARR COMPANY *Manufacturing Engineers*

Los Angeles • Chicago • New York

Mf'd under license by Control Equipment Co., Ltd., Montreal, Canada

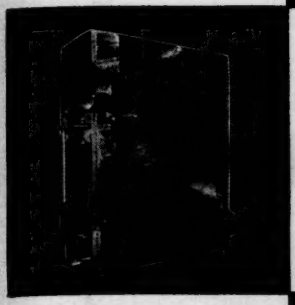
ACME PRODUCTS

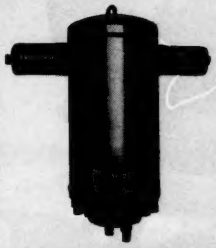


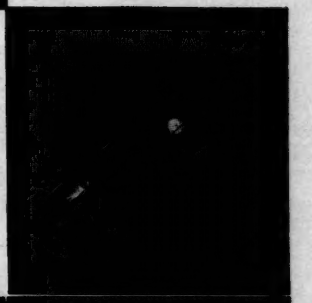
specify

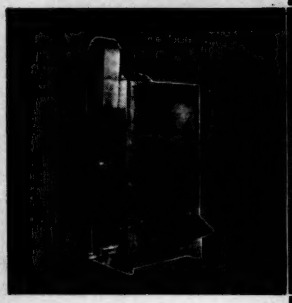
Acme

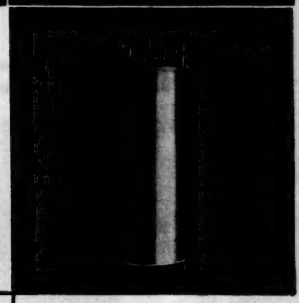
for engineering QUALITY and PERFORMANCE











When you specify "ACME" your equipment problem is greatly simplified, because the "ACME" Line is so complete that you will always find a product, model and size tailored to fit *every* refrigeration requirement.

DRY-EX* WATER CHILLERS

More than 700 combinations of heads, baffle spacings and tube lengths, capacities from 1 to 200 tons. High rate of heat transfer; replaceable tubes; optional choice of single or dual circuits on 12" or larger; positive oil return without the need for oil separator; improved head design, tube hole grooving, tube rolling and baffle construction, make ACME DRY-EX* Water Chillers *truly outstanding.*

EVAPORATIVE CONDENSERS

for Freon or Ammonia in more than 30 models with capacities from 120,000 to 1,250,000 BTU/Hr. Separable fan sections. Provision for internally mounted receivers. Top vertical or front or rear discharge is optional and the air inlet can be located either front or rear. Vented, ball bearings fan shaft bearings can be mounted in any position.

ACME OIL SEPARATORS

Two separate series, Ten Models for Freon and six for Ammonia. ACME Oil Separators provide positive oil separation, are easily accessible, require practically no maintenance and help to muffle compressor discharge noise.

ACME CONDENSERS

Are noise-free, easy to clean and have leak proof joints. A complete line of Freon, Ammonia, Shell and Tube and Shell and Coil is offered. You can choose from more than 120 standard sizes to get the right model to meet *every* requirement.

ACME COOLING TOWERS

Available in capacities from 3 to 40 Tons. Induced draft design offers increased efficiency, with quiet operation and water saving features. Housing constructed from *11 and 14 Ga.* steel. NON-CORROSIVE Cooling Pads. Hot-dip galvanized *after* fabrication.

ACME HEAT EXCHANGERS

A new, more compact design featuring low suction pressure loss. Available in 11 models with capacities from 3 to 200 tons, and has a 13 to 1 ratio of gas to liquid side surface.

ACME LIQUID RECEIVERS

Offered in more than 70 standard sizes, from 6⅝"x18" to 30" x240", for Freon, Ammonia or other refrigerants — are easy to install and maintain.

HI-PEAK* WATER COOLERS

have large storage capacity and are galvanized *after* fabrication. Offered in seven standard sizes. For intermittent or continuous operation. EVERDUR Tank and factory insulation are optional.

BLO-COLD* INDUSTRIAL UNIT COOLERS

Five distinct series in more than 260 combinations with dry coil operation or continuous brine spray defrosting or for flooded Ammonia operation. Coils are easily accessible, fan sections are separable and large doors facilitate inspection. Hot Dip galvanized *after* fabrication.

Wherever refrigeration is used, ACME major components are in evidence and have deserved the preference of the Industry for more than 30 years — Write for Catalog and further information on any item required.

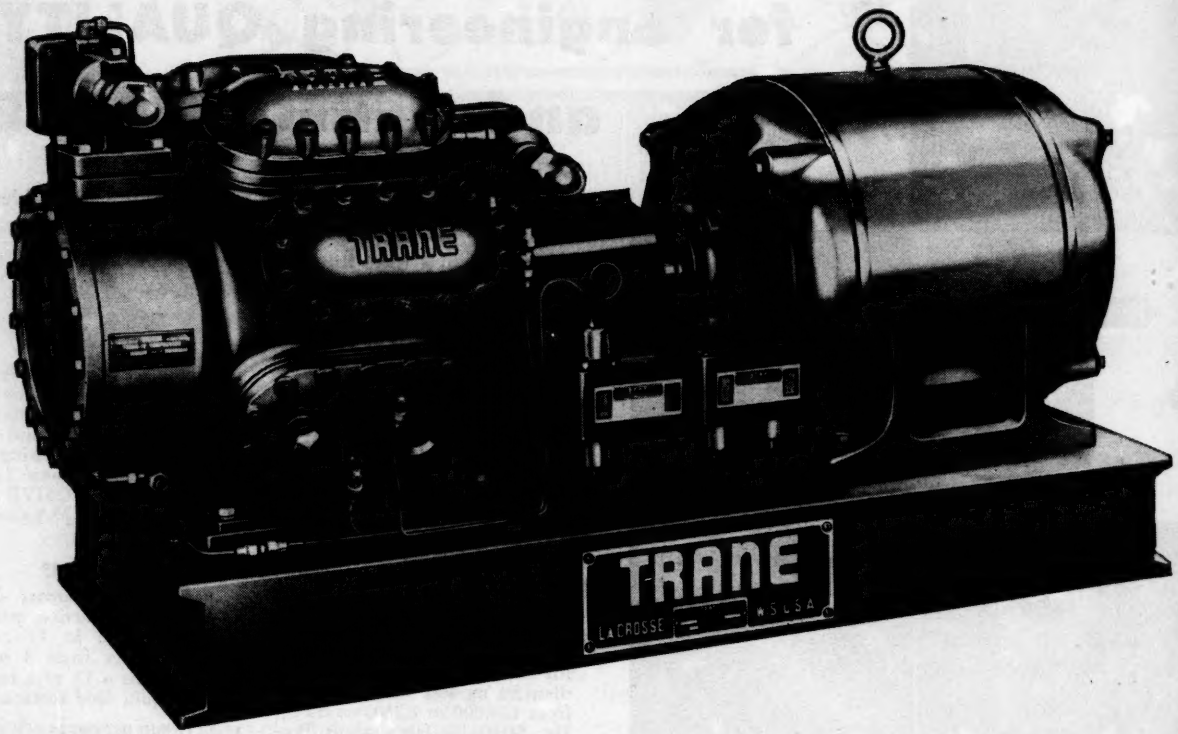
**Trade Mark*

Acme INDUSTRIES, INC. JACKSON, MICHIGAN

CONTINUOUSLY SERVING THE REFRIGERATION INDUSTRY SINCE 1918

MODERN DESIGN FOR

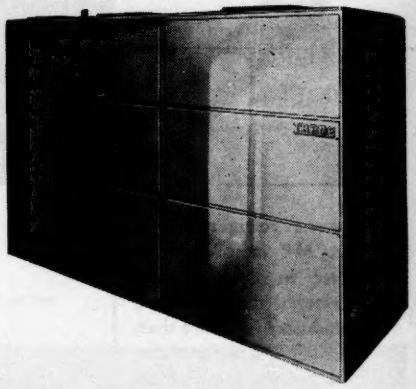
TRANE refrigeration



Now! New 15 and 20-Ton Self-Contained Air Conditioners

A Complete System in an Easy-to-install Package

Everything for complete air conditioning—compressor, condenser, evaporator and fans—in one compact unit. Factory engineered, built and assembled so only simple water piping and electrical connections are required. Available with water cooled or evaporative condensers built right into the unit. For the consulting engineer—an easy-to-specify, easy-to-install unit on the medium sized job. For the heating contractor—an easy way to get into the profitable air conditioning business.



MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING

PLUS PERFORMANCE—

for air conditioning

Now, more than ever before, TRANE provides a single, reliable source for creating the weather conditions demanded by today's building design. TRANE refrigeration and air conditioning products including coils, units of all kinds and fans, are designed together and built together for use together.

In the complete TRANE line there are both centrifugal and reciprocating compressors—offering a wide range of capacities from 3 to 200 tons. What's more, TRANE offers you *both* types of compressor equipment so that you can select precisely the kind of equipment that is right for your job.

Power saving unloader operation! Drastically reduced valve wear!

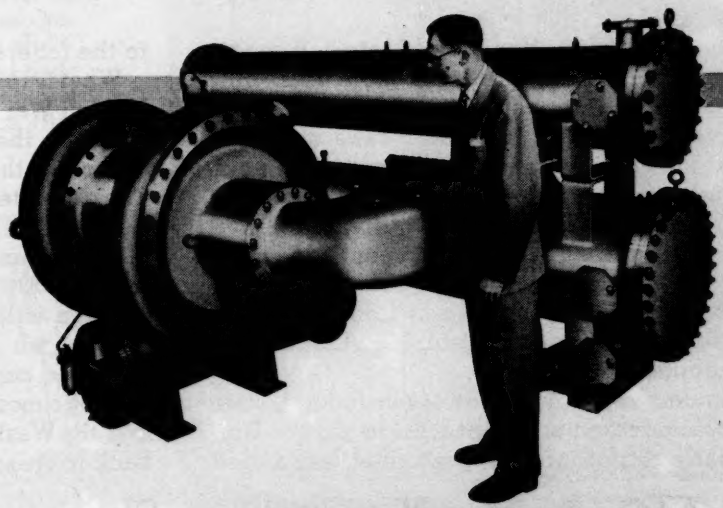
TRANE RECIPROCATING COMPRESSOR

This new masterpiece of modern design provides reduced power requirements as air conditioning loads are reduced—provides smoother, quieter operation over a longer period of time.

Cylinder loading and unloading is completely automatic as loads increase or decrease. Special design keeps refrigerant always free of dirt and oil.

Available with condenser mounted on top. In sizes up to 50 tons.

See TRANE Bulletin DS-361 for further information.



TRANE CenTraVac

First hermetically sealed centrifugal compressor! First in capacities as low as 45 tons! Capacities range from 45 to 200 tons. When air conditioning loads are reduced the TRANE CenTraVac automatically responds with lowered power consumption. This means power economies.

TRANE

THE TRANE COMPANY, LA CROSSE, WIS.

AND VENTILATING EQUIPMENT

"I wonder what happened to me !" said Alice

ALICE in Wonderland ate the magic cake and grew until she was more than nine feet tall. Our National bureaucracy also seems to have partaken of the magic cake of power. Bureaus in our government have grown in number and scope until their activities now control, to a great extent, the lives of all individual Americans. Department after department adds more and more people -- state, justice, commerce, treasury--not to mention those sprawling emergency born agencies of price control, N.P.A. and other alphabetical subdivisions.

The number of employees of our federal, state and local governments continues to grow. During many recent months, personnel was added to the federal payroll at the rate of 1,500 daily.

What is the reason for this mushrooming? The Korean War? Threat of war in Europe, Southeast Asia, or the Middle East? Obviously not! A glance at the federal budget gives the answer. The estimated cost of all governmental functions for the fiscal year 1952 is in excess of 70 billions of dollars, an increase of 26 billions, or approximately 60% more than last year.

When will it end? Only you, the individual citizen, who carries the bureaucratic load on his back, can stop it. It will end when enough patriotic men and women demand from congress that the Washington Wonderland start shrinking back to reasonable proportions.

YOUR SCRAP IS NEEDED — YOUNGSTOWN

The Youngstown Sheet and Tube Company

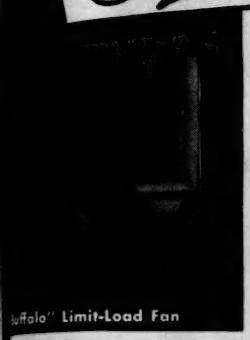
General Offices -- Youngstown 1, Ohio
Export Offices--500 Fifth Avenue, New York

MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

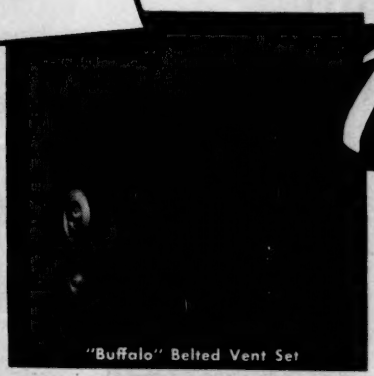
The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment

"Buffalo"

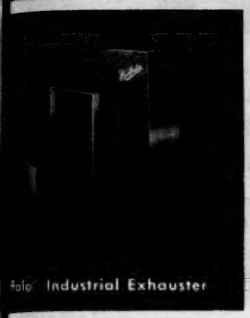
Tips on the Care of AIR EQUIPMENT



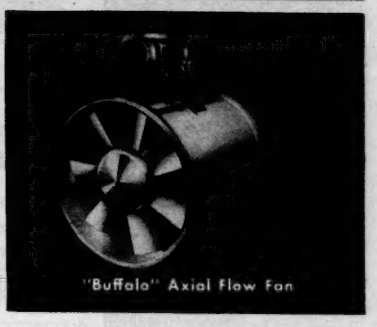
"Buffalo" Limit-Load Fan



"Buffalo" Belted Vent Set



"Buffalo" Industrial Exhauster



"Buffalo" Axial Flow Fan

1 Protective TREATMENT FOR LONGER FAN LIFE

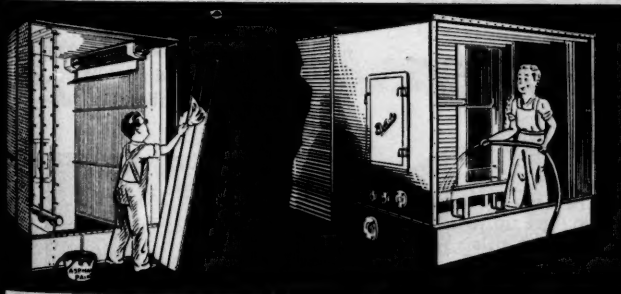
Frequent inspections and cleaning will make any fan run better and last longer. The cleaning not only retards corrosion, but prevents dust, dirt and grease from building up at various points on the blades and creating an unbalanced rotor condition.

Regular painting is good fan insurance. For ordinary ventilating jobs where moist air is handled, asphalt or bitumastic paint proves satisfactory. However, for the corrosive gases, rubber lining or special metals such as stainless steel may be necessary. "Buffalo" builds a fan for every job—ventilation, exhaust, air conditioning, draft, pressure blowing.

Write for facts on your air problems!

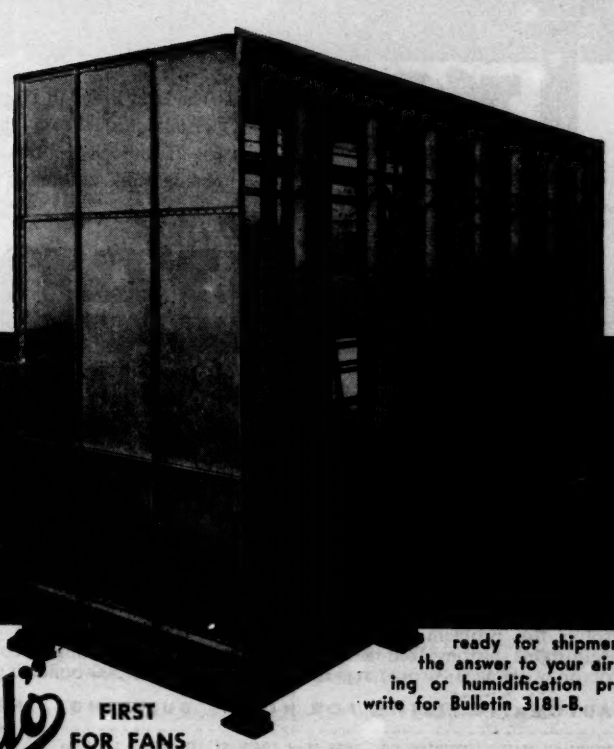
2 KEEPING THE AIR WASHER AT ITS BEST

A regular program of cleaning and painting as illustrated below is excellent preventive maintenance. This prevents scaling and corrosion due to evaporation of water which contains large quantities of dissolved solids. Regular maintenance, plus good basic design, are the reasons why many of the original "Buffalo" Air Washers are still in active service after more than fifty years.



Air washer eliminator plates should be painted yearly or oftener if necessary.

Frequent cleaning and flushing prevents corrosion.



ready for shipment. For the answer to your air washing or humidification problem, write for Bulletin 3181-B.

"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

480 BROADWAY BUFFALO, NEW YORK

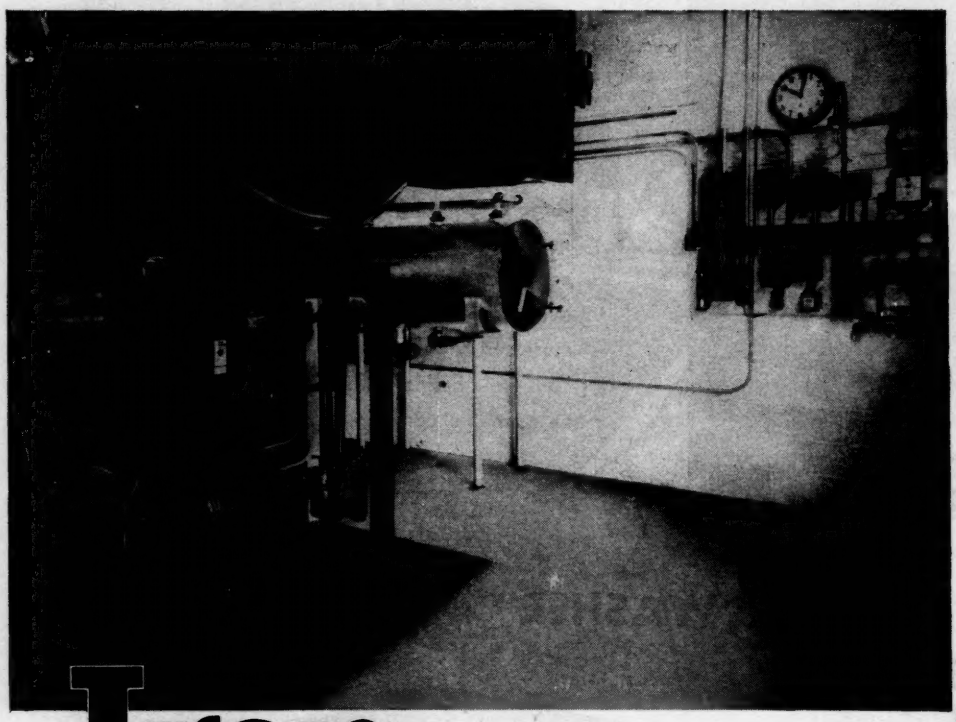
PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING

ED DRAFT COOLING HEATING PRESSURE BLOWING

We save $3800 a year with our Iron Fireman Rotary Oil Burner



says Mr. J. Mayberry, vice-president, Quality Mills, Inc. Mount Airy, North Carolina

"Our Iron Fireman Rotary Oil Burner has resulted in $1,800 per year savings in fuel cost over our previous firing method. In addition to this, other boiler room economies amount to approximately $2,000 per year. The efficiency of this unit has enabled us to save a great deal of time on many of our operations calling for quick steam."

The Iron Fireman Horizontal Rotary Oil Burner installed in the Quality Mills boiler is rated at 75 gallons per hour. It burns No. 6 oil and being fully automatic, requires little attention.

Iron Fireman

Horizontal Rotary Oil Burner

fires fuel oil of any weight with complete dependability

The changeable viscosity of heavy oils was heretofore the toughest problem in firing these heat-rich economical fuels. When warm, they flow freely—when cold, they are almost as sluggish as tar. The Oil Volumeter, with which the Iron Fireman burner is equipped, solves this problem of varying viscosities. Adjustable pistons feed a definite *volume* of oil with each stroke, regardless of the physical properties of the oil.

You save two ways. The heavy oils cost you less per gallon, yet you get up to 12% more Btu's than from lighter oils. The Iron Fireman Rotary Oil burner keeps a steady flame even when throttled down to less than 20% of capacity. . . Facilitates quick starting in cold boilers. . . Capacities up to 500 boiler h.p.

AUTOMATIC FIRING FOR HOMES, BUILDINGS, INDUSTRIAL PLANTS

IRON FIREMAN MANUFACTURING CO., 3278 West 106th St., Cleveland 11, Ohio.

Please send literature as checked:

- ☐ Rotary Oil Burner
- ☐ Commercial Gas Burner
- ☐ Coal-Flow Stoker

Name_____

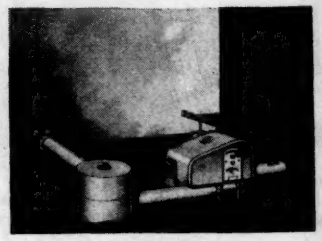
Address_____

City_____ State_____

Mail coupon for literature and complete information.

Iron Fireman Commercial Gas Burner

Vertical type has zone control for modulated firing. Other gas-saving models include Radiant Inshot, Ring-Type and combination oil-gas burner.



Iron Fireman Coal-Flow Stoker

Feeds coal direct from bin. No coal handling. Fuel and air supply synchronized for utmost efficiency. Capacities to 500 boiler h.p.

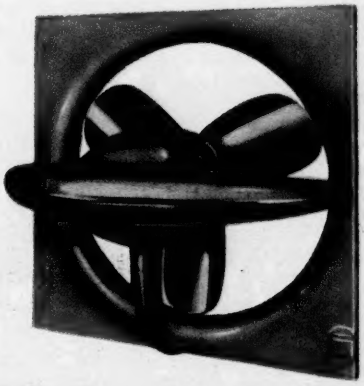
...erican Blower – a time-honored name in air handling

Nothing, absolutely nothing, overcomes the objections to bad odors quite as well as removing them.

And American Blower Ventura Fans (see above) do this job quickly, quietly and at low cost.

Ventura Fans, Utility Sets, Heating, Cooling Coils, and complete Air Conditioning Units are but a part of American Blower's line of quality products.

You can profit from these products. Phone our nearest branch office for data.



American Blower Model A Ventura Ventilating Fan. Capacities from 1000 cfm to 9700 cfm, free delivery.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

AMERICAN BLOWER

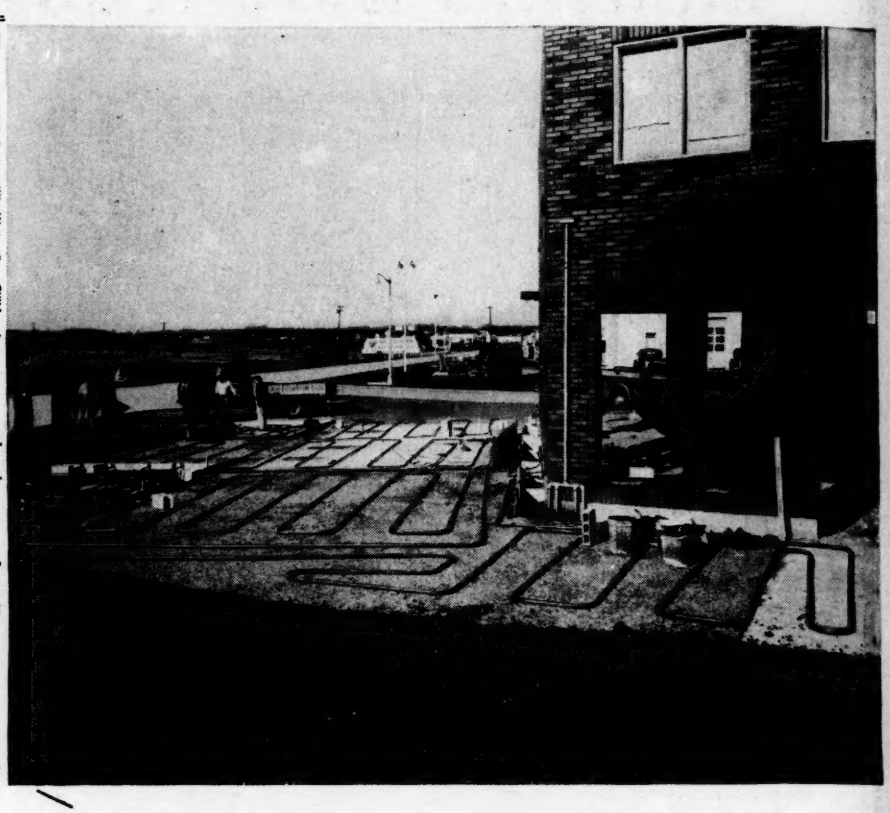
YOUR BEST BUY IN AIR HANDLING EQUIPMENT

Serving home and industry

...CAN-STANDARD • AMERICAN BLOWER • ACME CABINETS • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON

Man the pumps

and let 'er snow!



Service stations with steel pipe snow melting get the business

It takes a constant flow of cars at the gas pumps to keep a modern service station operating profitably, for traffic and sales go hand-in-hand. Anything that interferes with the station's capacity to fill 'em up and keep 'em moving, naturally reduces the profit.

Sudden and heavy snow falls that slow down normal operations, sometimes for days at a time, not only result in disgruntled customers but, perhaps, in permanent loss of business as well. It need *not* be so! Foresighted operators of service stations with steel pipe snow melting systems do "business as usual" . . . while competitors shovel!

The known economy of steel pipe makes investment in a snow melting system practical for service stations, just as it does for super-markets, decentralized shopping areas and any business dependent upon automobile patronage. And in service, steel pipe has a performance record proved in more than 60 years of conventional hot water and steam heating applications. Add to this the advantages of formability and weldability for coil fabrication and you know why steel pipe is first choice for snow melting systems, too, and why it is the most widely used pipe in the world.

Steel Pipe is First Choice

COMMITTEE ON STEEL PIPE RESEARCH

AMERICAN IRON AND STEEL INSTITUTE

350 Fifth Avenue, New York 1, N.Y.

mondays were really BLUE in the 90's

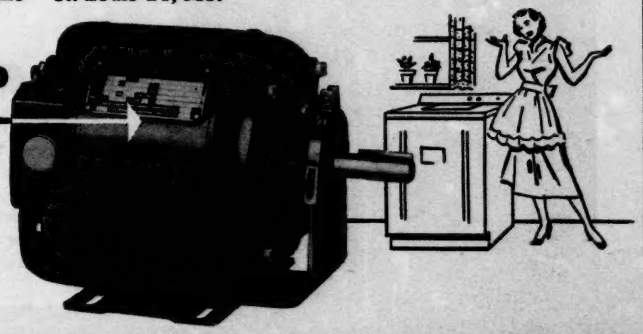
Men folks worked from sun to sun . . . but Mother's work was never done . . . in the 90's. Wash days added to her burden . . . she spent many hours toiling near a hot, kitchen stove.

The electric motor has worked miracles to relieve mankind of time-consuming, laborious tasks and provide for the living standards we enjoy today.

Emerson-Electric is recognized as a leader in producing motors which power a long list of MODERN home appliances. To name just a few: automatic washers, ironers, dryers, refrigerators, freezers, oil burners and stokers.

Founded more than half a century ago, Emerson-Electric builds dependable, efficient motors for use in appliances and equipment for the home, on the farm, in business and in industry. Your inquiry is invited on the complete Emerson-Electric motor line, in horsepower ratings from 1/20 to 5. THE EMERSON ELECTRIC MFG. CO., St. Louis 21, Mo.

MODERN LIVING **IS POWERED WITH ELECTRIC MOTORS**



OIL BURNER MOTORS

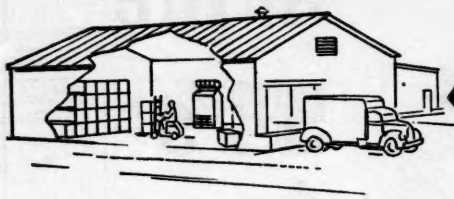
No matter how good your Oil Burner may be, it can be no more reliable than the motor that drives it. Emerson-Electric oil burner motors are specially designed and precision-built for this job . . . they are totally enclosed, extra quiet in operation, require a minimum of maintenance and meet Underwriters' Laboratory specifications for oil burner service. Write for Oil Burner Motor Data Bulletin No. M95.

EMERSON ELECTRIC
MOTORS • FANS APPLIANCES

LEADERS IN THE FAN AND MOTOR INDUSTRY SINCE 1890

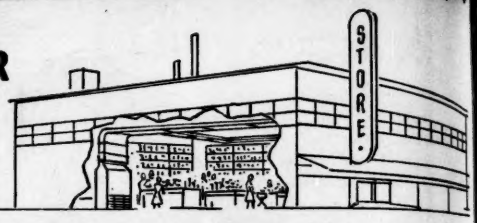
DRAVO *Counterflo*

A POSITIVE *SOLUTION* FOR



1. INDUSTRIAL CENTER

Where space is limited or roof heat losses are unusually high, Dravo Heaters require minimum space . . . no expensive boiler plant; roof heat losses low due to controlled recirculation of air; can be used with or without ducts.

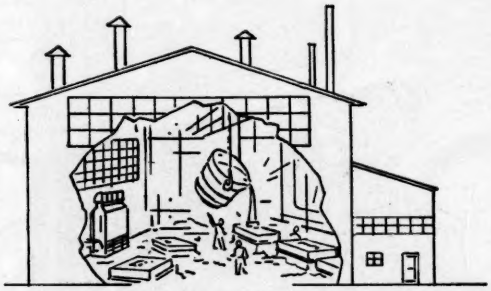


3. SUPERMARKET

In heating, ventilating and air conditioning large areas, Dravo Heaters can tie in with air conditioning system by using same duct work, provide year-'round comfort.

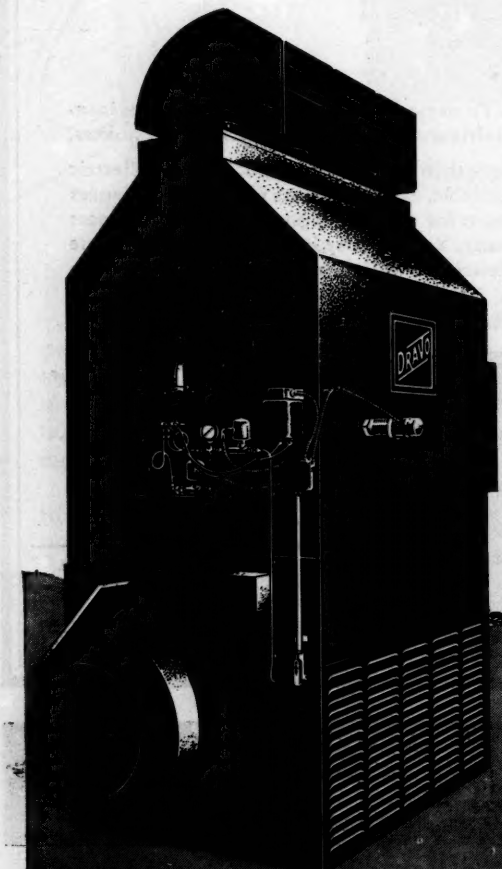
2. FOUNDRY

Negative pressures, caused by exhausting foul air, are balanced by tempering fresh outside air with Dravo Heaters. Atmosphere is kept healthy, constant temperatures are maintained, worker efficiency improves.



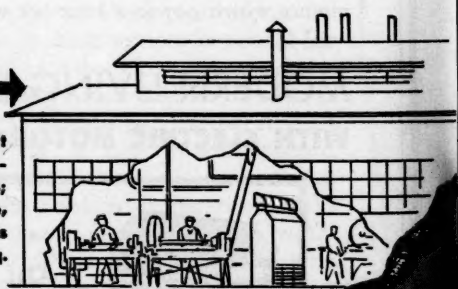
4. MEDIUM-TEMPERATURE CURING

In controlling temperatures and air moisture content in process manufacturing, Dravo Heaters have automatic controls, maintain constant temperature, can recirculate air to control curing process.



5. MACHINE SHOP

For comfort heating large plant areas, Dravo Heaters have maximum air throw in all directions; can be turned off during idle time, warm up quickly, keep fuel costs low, can heat 4,000 to 20,000 sq. ft. area, no duct work required.

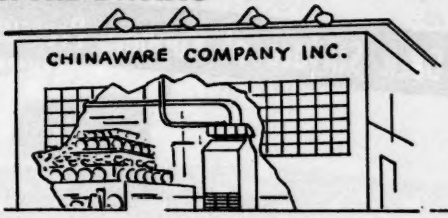


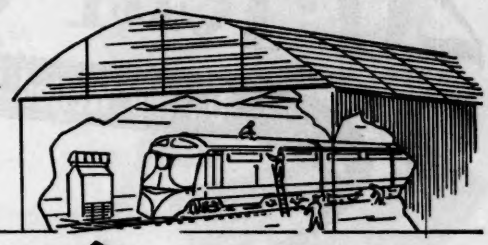
HEATERS.....

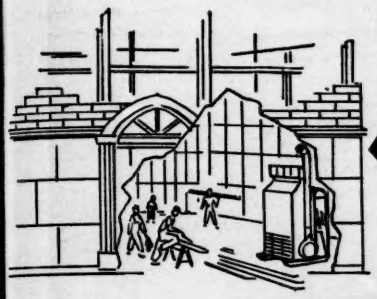
8 DIFFERENT HEATING PROBLEMS!

6. MEDIUM-TEMPERATURE DRYING

In removing moisture in drying operations, Dravo Heaters provide low-cost heat at even, predetermined temperatures; are automatic in operation, can use gas or oil, are readily converted.







7. TEMPORARY HEATING

For building construction projects where ground temperature must be kept above freezing, Dravo Heaters are quickly installed, easily moved to any location; can be later used as permanent heating plant for the new building.

8. RAILROAD REPAIR SHOP

In providing ample heat for repairmen in large buildings, Dravo Heaters keep heat where it's needed . . . at the working level; directional nozzles easily adjusted to suit conditions; heaters can be mounted on walls or hung from ceiling in any position.

DRAVO Counterflo HEATERS CAN SOLVE SIMILAR PROBLEMS IN THESE INSTALLATIONS, TOO

Comfort Heating and Ventilating in schools, churches, auditoriums, laundries, restaurants, garages, factories.

Process Drying of wood, rubber and paint; rug drying; auto laundry operations.

Process Curing of concrete pipe linings, farm crops, paper and fibres.

DRAVO HEATERS OFFER YOU . . .

- Low initial cost—usually require 30% to 40% less ceiling
- Easy installation—connections, duct and chimney requirements are only moderate.
- Flexibility—almost any space in factory can be used, being an independent unit heater.
- Low fuel cost—Counterflo, Dravo's patented principle, readily converts
- Automatic
- Long service life—

MAIL THIS COUPON FOR MORE INFORMATION . . .

Heating Department
Dravo Corporation
Dravo Building, Fifth and Liberty Avenues
Pittsburgh 22, Penna.

DRAVO

☐ Please send me Bulletin No. TU-523
☐ Please have a representative call.

Name_____

Title_____

Company_____

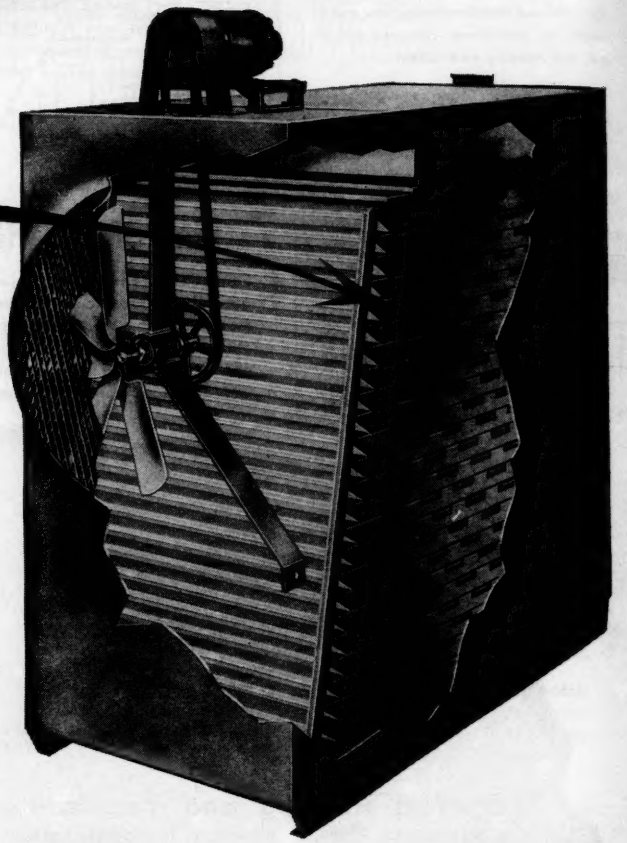
Address_____

City_____ Zone_____ State_____

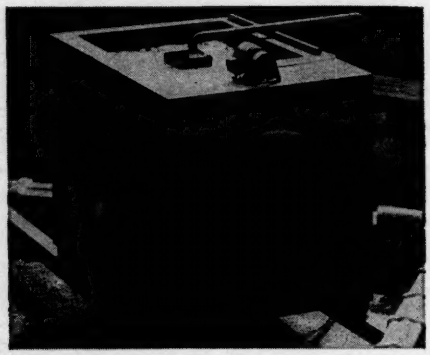
HALSTEAD & MITCHELL COOLING TOWERS

20-Year Guarantee!

On the Wetted Deck Surface of Koppers Pressure-Treated Wood



Here's the industry's greatest cooling tower value . . . "built like a battleship" for 20 years of foolproof performance. Halstead & Mitchell's pioneering in exclusive use of Koppers pressure-treated wood in the wetted deck surface makes possible the unprecedented 20-year guarantee against rotting, and provides the industry's most effective deterrent against fungi growth. Economical, lastworthy . . . the special H & M design for water distribution eliminates, thru the use of an efficient gravity-type distributing pan, extra pumping head required on spray type towers, also cuts down windage losses due to atomizing of water. The complete assembly is with Everdur bolts . . . disassembly is easy even after years of service. Easily accessible for cleaning through inlet on back of towers in all sizes.



MORE EFFICIENT IN ANY INSTALLATION

H&M # CT-4000 Induced-Draft Cooling Tower supplying the condensing water for 20 HP and 10 HP water-cooled condensing units in 3-story jewelry storeroom air conditioning. Note open-type distributing pan. This installation also has remote water basin in basement for year-round operation.

5 TONS to 50 TONS

A cooling tower for all applications, from 5 to 50-ton capacities—made by Halstead & Mitchell, one of the world's largest manufacturers of water-cooled Cleanable Condensers.

AT LEADING WHOLESALERS EVERYWHERE

Write for descriptive bulletin and information on engineering helps.

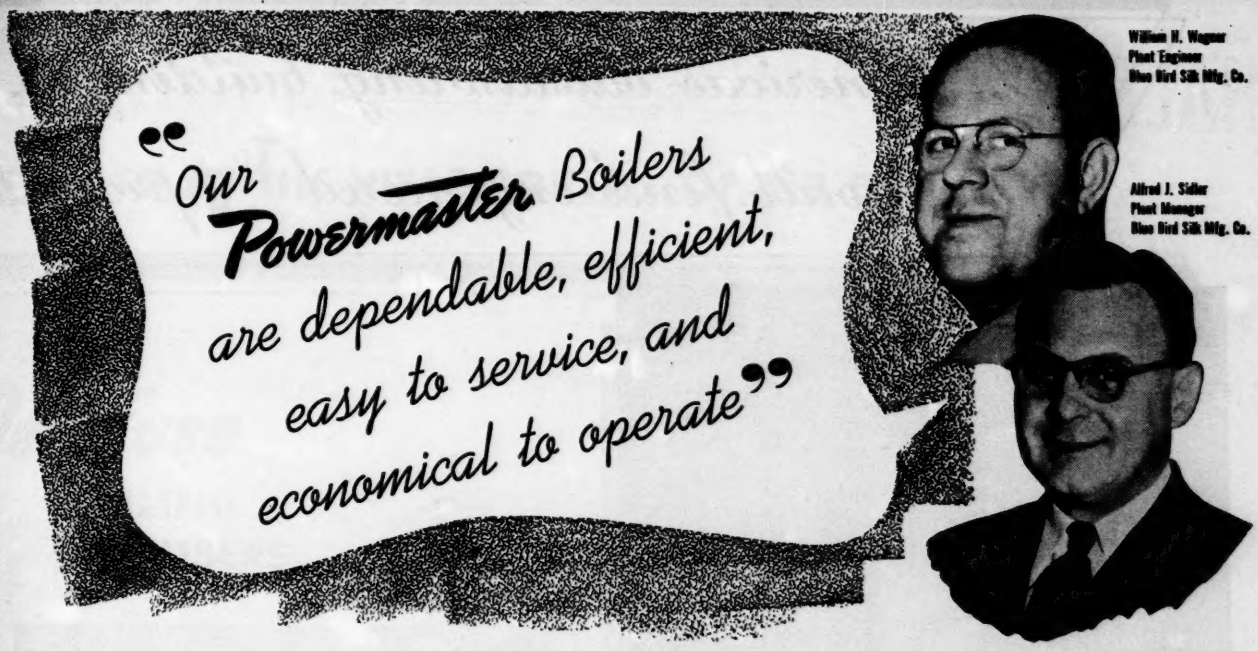
HOUSING—10 gage (⅛"+) sheet-steel case with 3 coats Bitumastic lining. Electrically welded cabinet. All bolts used are Everdur for ease of disassembly after years of service.

WATER DISTRIBUTION—Gravity type distributing pan eliminates extra pumping head, cuts down windage losses, due to atomizing water.

FAN AND DRIVE—Quiet-operating stainless steel 8-bladed fan, stainless steel shaft, chrome-dipped rust-proofed pulleys. Cast iron bearing supports. Adjustable belt tension.

HM Halstead & Mitchell

OFFICES: BESSEMER BUILDING • PITTSBURGH 22, PA.


"Our Powermaster Boilers are dependable, efficient, easy to service, and economical to operate"
William H. Wagner
Plant Engineer
Blue Bird Silk Mfg. Co.
Alfred J. Sidler
Plant Manager
Blue Bird Silk Mfg. Co.

20% Saving in Steam Cost at York, Pa. Manufacturing Plant

William H. Wagner, Plant Engineer of the Blue Bird Silk Manufacturing Company, knows the problems of generating high-pressure steam 24 hours a day, 365 days a year. And he knows how serious it can be for a busy manufacturing plant if there is trouble or failure in the boiler room. That's why, two years ago, the company replaced their old-fashioned coal-fired boilers with two 200 h.p. POWERMASTER packaged automatic boilers, burning #6 (Bunker C) oil. Here is what they found:

- The cost of producing steam for processing and heating dropped 20%.
- The steam produced now is much dryer.
- The POWERMASTERS respond very rapidly to variations in load.
- Maintenance has been negligible.

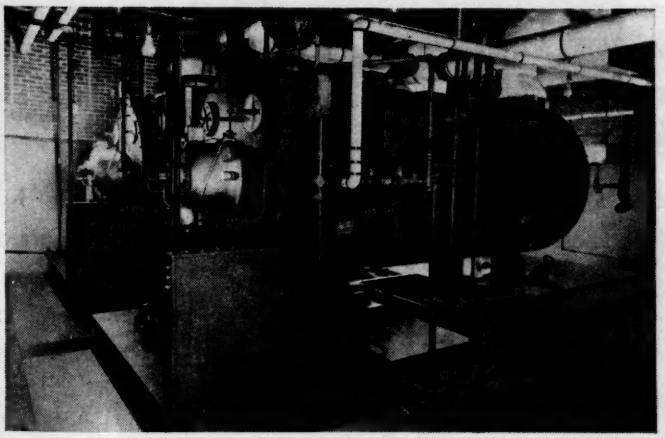
Little wonder that Alfred J. Sidler, Plant Manager, says, "If we had it to do over again, we would certainly buy POWERMASTERS."

No other packaged automatic boiler gives you *all 3 advantages of the Powermaster:*

1. SAVE FUEL—because the special *Powermaster* burner design gives you top efficiency when operating anywhere between 30% and 100% of capacity.
2. SAVE IN MAINTENANCE and clean-up time. Complete combustion of fuel gives practically smokeless and carbon-free operation. The burner has *no* moving parts to wear out . . . or to be cleaned daily.
3. CHANGE FROM OIL TO GAS (or gas to oil) in just a few minutes. Burn light oil, heavy oil, or gas—whichever is cheaper. You no longer need depend on one source of fuel supply.

Write for this Catalog

To get complete information about this modern packaged automatic boiler for steam or hot water, write for *Powermaster* Bulletin 1218. We'll be glad to put a copy in the mail for you.



These 200 h.p. POWERMASTER packaged automatic boilers have been operating round-the-clock for more than two years at the Blue Bird Silk Manufacturing Company, York, Pa. Burning #6 oil, they produce a total of 13,800 pounds of steam per hour.

Powermaster®

PACKAGED AUTOMATIC BOILERS

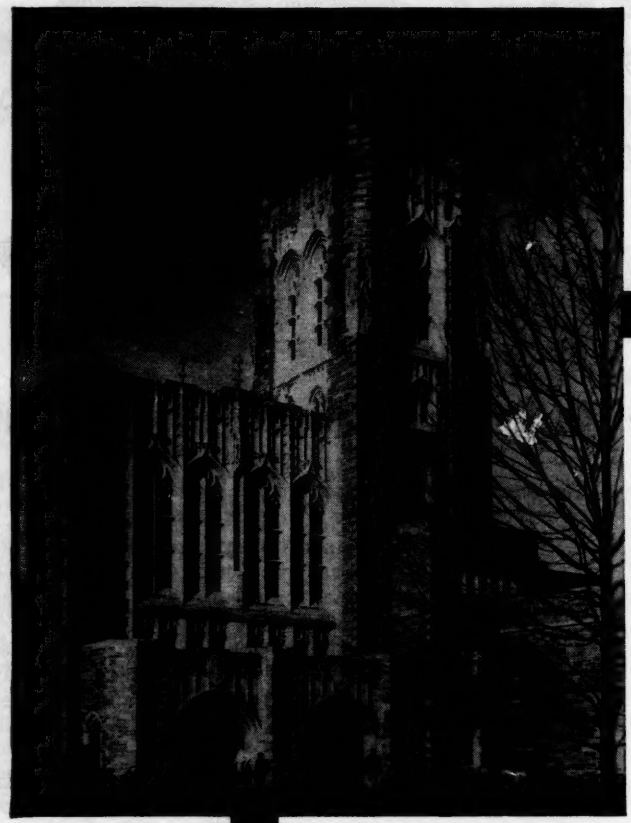
In sizes to 500 h.p.; pressures to 250 psi.

ORR & SEMBOWER, INC.

Established 1885

980 Morgantown Road, Reading, Pa.

In America's outstanding buildings... you'll find engineered T&B *products*



THE NEW
HARVEY S. FIRESTONE
MEMORIAL LIBRARY
at Princeton

R. B. O'CONNOR & W. H. KILHAM, JR.
Architects

MEYER, STRONG & JONES
Consulting Engineers

TURNER CONSTRUCTION COMPANY
General Contractor

ALVORD & SWIFT
Air Conditioning Contractor

Princeton's beautiful new Harvey S. Firestone Memorial Library now joins the parade of distinguished buildings in which Tuttle & Bailey Aerofuse Diffusers and Tri-Flex and Aerovane Grilles and Registers assure the engineered performance of the air conditioning system.

On contracts of such importance there can be no question about the success of the installation . . . and these Tuttle & Bailey units, backed by the Industry's most complete research, engineering and test facilities, insure the flexible precision control of air delivery necessary to meet exacting specifications.

In addition, all Tuttle & Bailey units meet the standards of distinction and good taste in design so important in carefully detailed interiors.

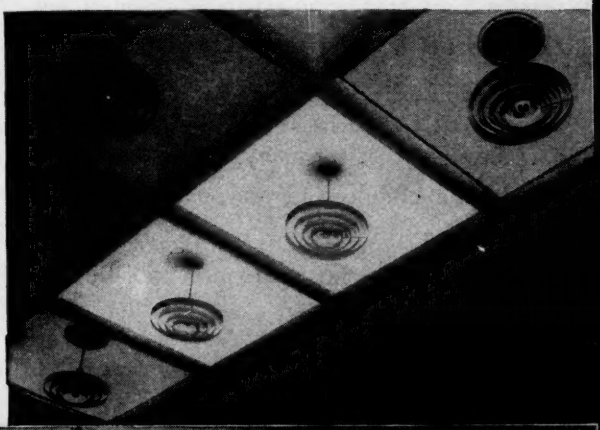
Specify Aerofuse Diffusers and Tri-Flex and Aerovane Grilles and Registers and be sure of the best without compromise. Write us direct for Catalogs No. 104 and 48S giving full information.

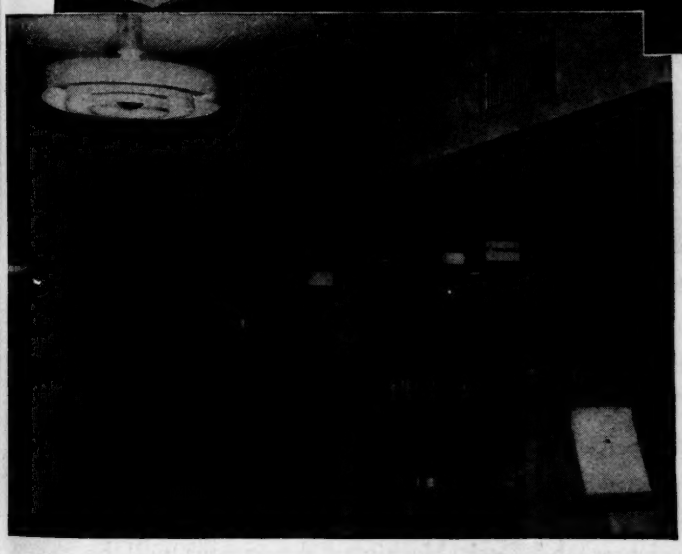
ST852

INSTALLED AT THE VITAL POINT...OF AIR DELIVERY

Aerofuse

CEILING DIFFUSERS





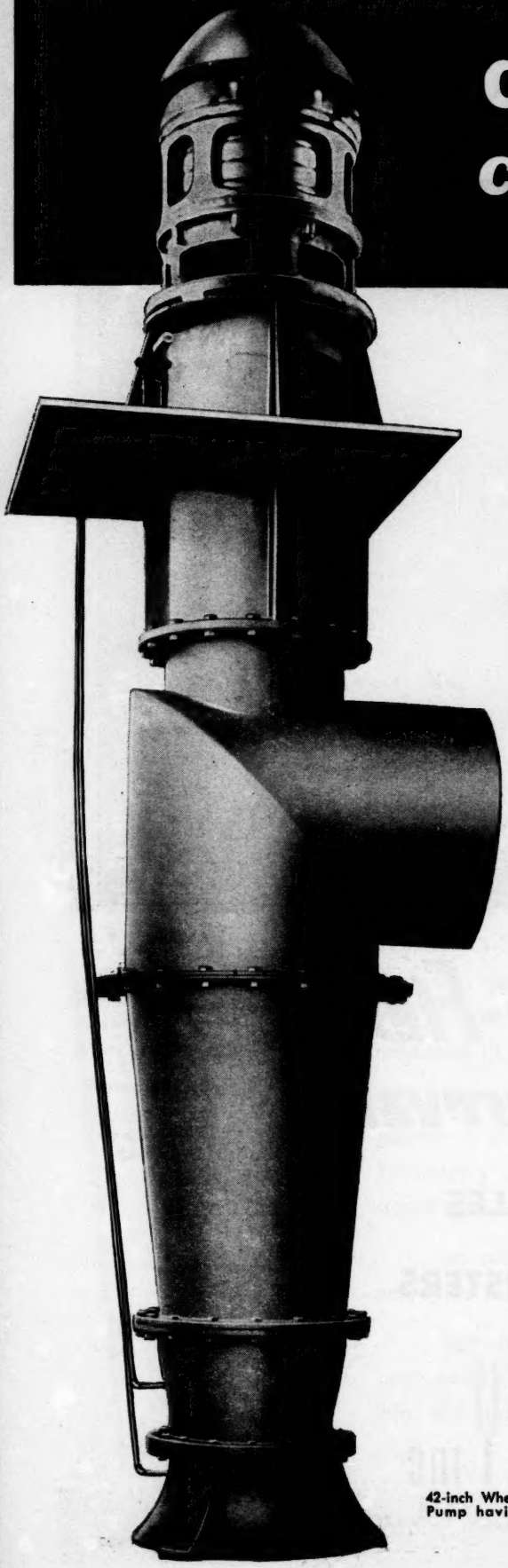
Tri-Flex Aerovane

GRILLES *and* **REGISTERS**

TUTTLE & BAILEY inc

NEW BRITAIN, CONNECTICUT

C. H. WHEELER & CONSOLIDATE TO



42-inch Wheeler-Economy Vertical Axial Flow Pump having capacity of 40,000 G.P.M.

Economy Pumps, Inc. and C. H. Wheeler Manufacturing Company have consolidated engineering and manufacturing facilities in C. H. Wheeler's plant at Philadelphia. Facilities are now being expanded through new construction and the installation of additional modern machine tool equipment.

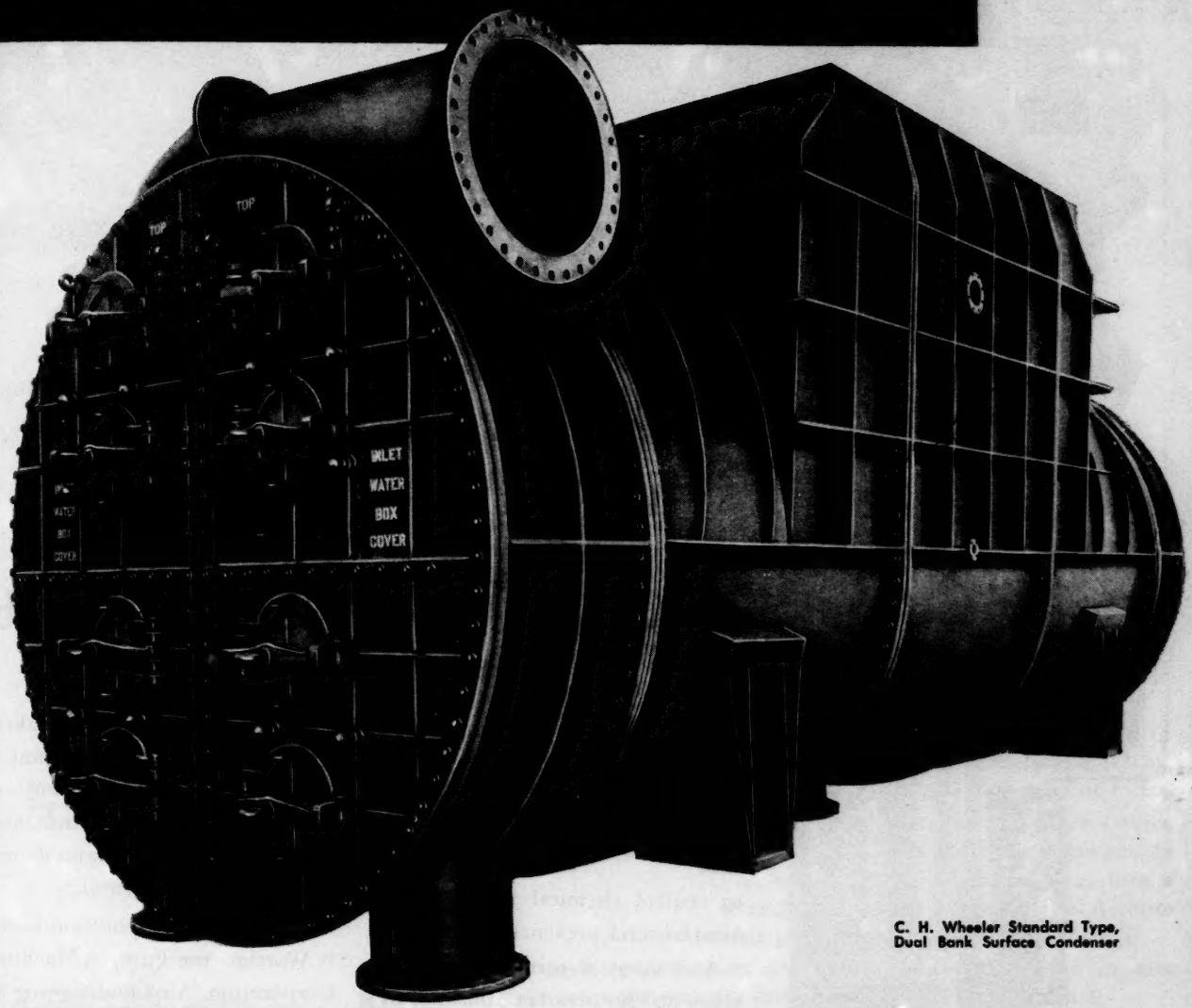
PUMPS . . . Economy has for many years been among the leaders in the engineering and manufacture of centrifugal, axial and mixed flow pumps. Today, the Wheeler-Economy line is one of the most modern and complete in the pumping industry.

CONDENSERS & POWER PLANT EQUIPMENT . . . The C. H. Wheeler Manufacturing Company has contributed many of the outstanding developments in the field of condensing apparatus and vacuum problems. Nearly a decade ago, C. H. Wheeler adopted Economy mixed flow pumps for use with their condensers.

PROCESS EQUIPMENT . . . C. H. Wheeler is also internationally known for Cooling Towers, Steam Jet vacuum apparatus and Fine Particle Reduction Mills, vital links in modern chemical and food processes. Wheeler-Economy Pumps will round out the company's services in these fields.

MARINE GEAR . . . C. H. Wheeler's Marine Gear, Condenser and Deck Machinery department will be augmented by Wheeler-Economy Pumps designed for marine application.

ECONOMY PUMPS, Inc.
SERVE YOU BETTER . . .



C. H. Wheeler Standard Type, Dual Bank Surface Condenser

WHEELER-ECONOMY PUMPS

. . . a new name combining old names that have been known and respected for generations. All the experience and metal working techniques this consolidation brings together are of great importance to you — our customer. Wheeler-Economy Pumps will fill your every requirement regardless of size or problem involved. Write to Philadelphia or to the nearest Economy or Wheeler representative listed in the phone directories of principal cities.

113

WHEELER-ECONOMY PUMPS

ECONOMY PUMPS, INC. · DIVISION OF C. H. WHEELER MANUFACTURING CO.
19TH AND LEHIGH, PHILADELPHIA 32, PA.

GOOD REMEDY for business ailments

Many of the big pharmaceutical houses use Worthington air conditioning and refrigeration machinery to control chemical reactions, inhibit bacteria, prevent deterioration.

And many a corner drug store keeps up "hot weather" business by using Worthington air conditioning to bring in customers.

No other manufacturer makes *so complete* a line. A Worthington system is all Worthington-*made* — not just Worthington-assembled — assuring you of perfectly balanced operation and unit responsibility.

Worthington Corporation, formerly Worthington Pump & Machinery Corporation, Air Conditioning and Refrigeration Div., Harrison, N. J.

America's Leaders... in Many Businesses... Select

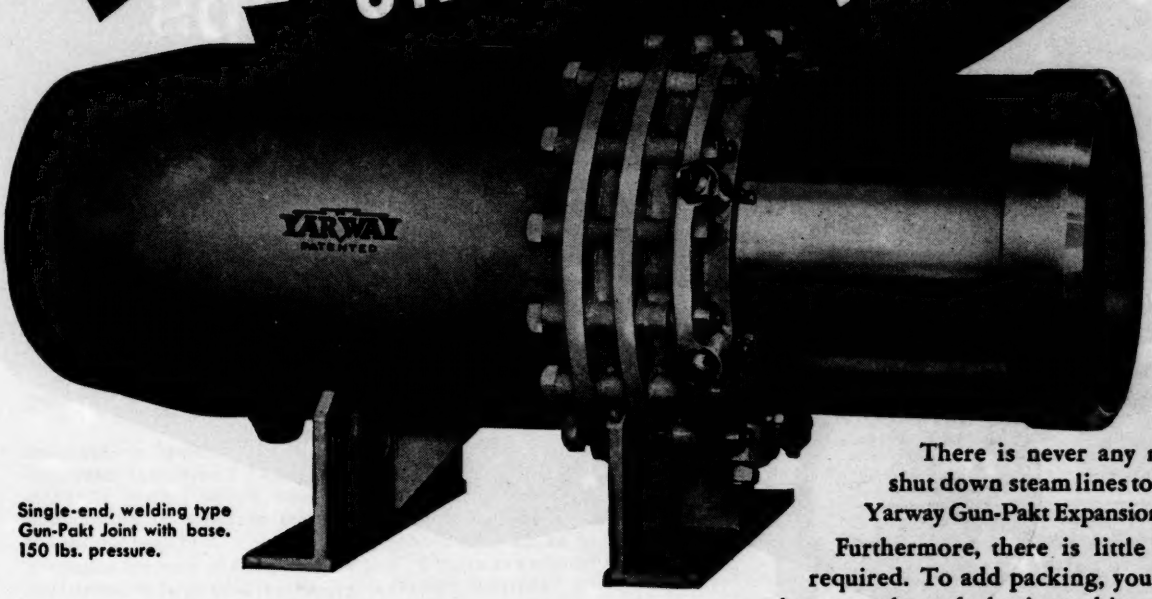
WORTHINGTON

A.2.8

AIR CONDITIONING AND REFRIGERATION

The Most Complete Line... Always the Correct Recommendation

THIS EXPANSION JOINT IS SERVICED UNDER FULL STEAM PRESSURE



Single-end, welding type Gun-Pakt Joint with base. 150 lbs. pressure.

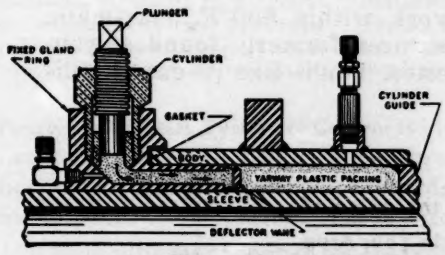
There is never any need to shut down steam lines to service Yarway Gun-Pakt Expansion Joints.

Furthermore, there is little service required. To add packing, you simply insert a plug of plastic packing, turn a wrench, and the job's done! Special Alemite fittings provide for proper lubrication.

Maintenance costs are trifling. One large user reports 65 cents per year per joint. Others claim less than that.

Gun-Pakt Joints are available with single or double-ends, welding or flanged types, in sizes from 2" to 30", with traverses from 4" to 24", and for pressures to 400 psi.

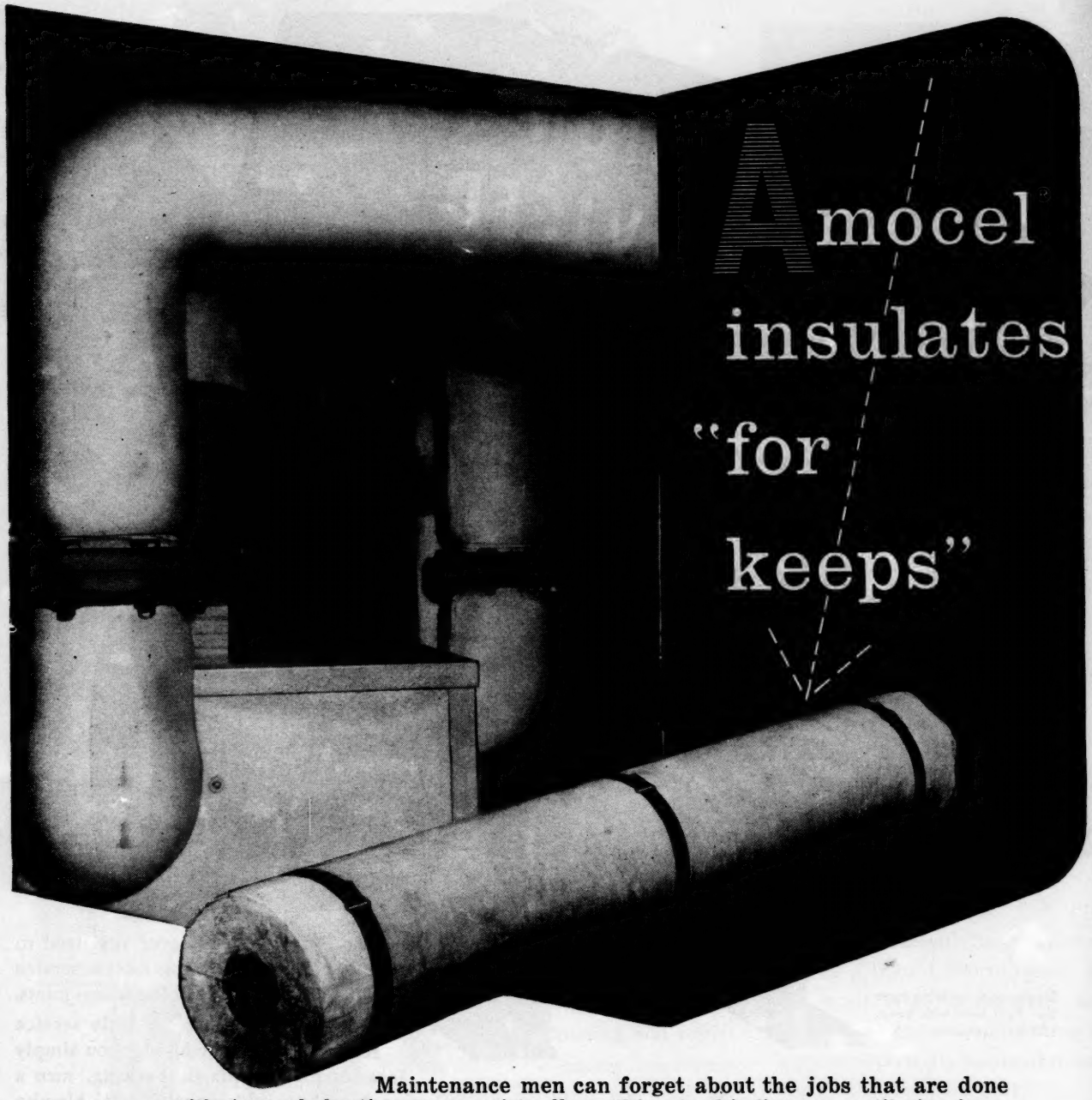
For the full Gun-Pakt story, write for Yarway Bulletin EJ-1912.



Close-up of cross-section showing detail of Gun-Pakt feature.

YARNALL-WARING COMPANY
104 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

YARWAY **GUN-PAKT EXPANSION JOINT**



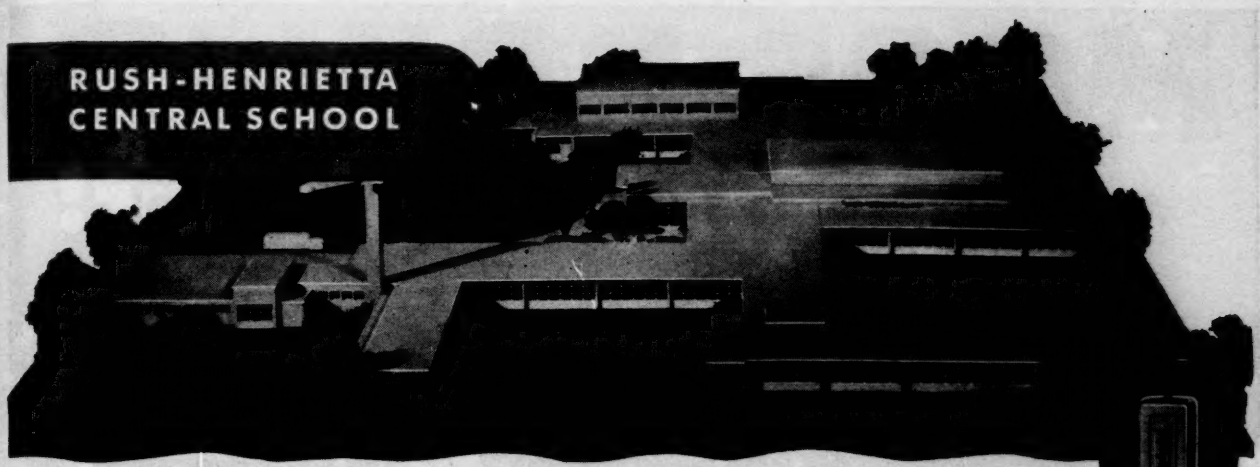
Maintenance men can forget about the jobs that are done with Amocel, for time means virtually nothing to this "permanent" pipe insulation. It's Unarco's exclusive development for low-cost commercial use on steam and hot water lines and for all other work within 600°F., maximum. Amocel has many of the fine extra-service features formerly found only in Unarco's higher-temperature insulation, Unibestos. You'll like its easy application; its money-saving, long-lived efficiency.

UNARCO

Write for Bulletin No. 76-109, and the name of the Unarco Warehousing Distributor in Your Area

UNION ASBESTOS & RUBBER COMPANY

DEPT. B-5 332 SOUTH MICHIGAN AVENUE . CHICAGO 4, ILLINOIS



Architects: ADE and TODD Rochester, N. Y. ● Consulting Engineers: ROBSON & WOESE, Syracuse, N. Y.
Heating Contractor: W. A. McCORMICK, Rochester, N. Y.

POWERS
RADIANT HEATING CONTROL

—used in many prominent modern buildings

Here is one of the nation's prominent modern schools with a radiant heating system supplemented by mechanical ventilation —completely controlled by Powers.

For flexibility of adjustment and better control the temperature regulating system is divided into six zones.

Each Zone—is heated by circulated hot water regulated by a Powers MASTROL system which controls temperature of water in relation to outdoor weather.

Ventilation for each of the six zones is supplied by large unit ventilators controlled by a Powers duct thermostat operating Flowrite valves and dampers.

Auditorium is heated by a central fan ventilating system. **Gymnasium** is heated by two large unit ventilators. Both types of ventilation circulate room air except when rooms are occupied at which time outside air is proportioned to the load. Temperature in both of these spaces, as well as in the Locker Room, is regulated by various Powers controls.

Steam Boiler Control for Varying Loads Three oil-fired boilers here are regulated by a Powers No. 252 Pneumatic Pressure Regulator controlling three PE switches which cut in the right number of boilers required for the heating load.

Powers MASTROL System of Control is ideally suited for radiant heating. It has been widely used to control many types of forced hot water heating. Performance records show it unsurpassed for reliability. Maintenance cost is practically nil.

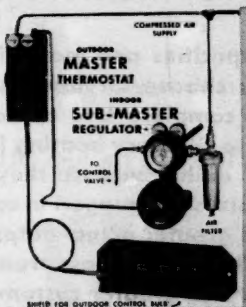
When problems of control for any type of heating or air conditioning arise, call Powers. Our more than sixty years of experience in supplying control for important buildings may be helpful to you.

(a81)

Ceiling Coils before plastering

81 Powers Individual Room Thermostats here, control...

87 Powers NO-PAK Valves (packless, non-leaking type) which regulate heat in ceiling coils. Each room is provided with the temperature desired.



Powers MASTROL System of Control in each of 6 zones regulates the temperature of water circulated from steam heated hot water converters to various rooms. Temperature of water is maintained in direct relation to weather out-doors.

Powers FLOWRITE Control Valves Regulate steam to Hot Water Converters • Heating coils in Classroom Ventilators • Central Fan System in Auditorium • Large Unit Ventilators in Gymnasium.

Only a few of our many types of control for Radiant Heating are shown here.

for your dollar!

15 different Circulators

TWO TYPES • HORIZONTAL OR VERTICAL

EACH DESIGNED FOR ITS RATED CAPACITY

LARGER MOTORS • HEAVIER CONSTRUCTION

COMPARE capacities and motor horse power as well as size when you choose Circulators and you'll choose Thrush. Here is a complete line of horizontal or vertical Water Circulators to fit every heating job. They offer more for your circulator dollar because they're built better . . . even the smallest sizes are rugged in construction and have larger motors with greater actual output than other makes of equal rating. That means less trouble on the job . . . fewer service calls and greater customer satisfaction. Patented coupling eliminates vibration. Lubrication is sealed in. Ask your wholesaler about them or write Dept. D-5.

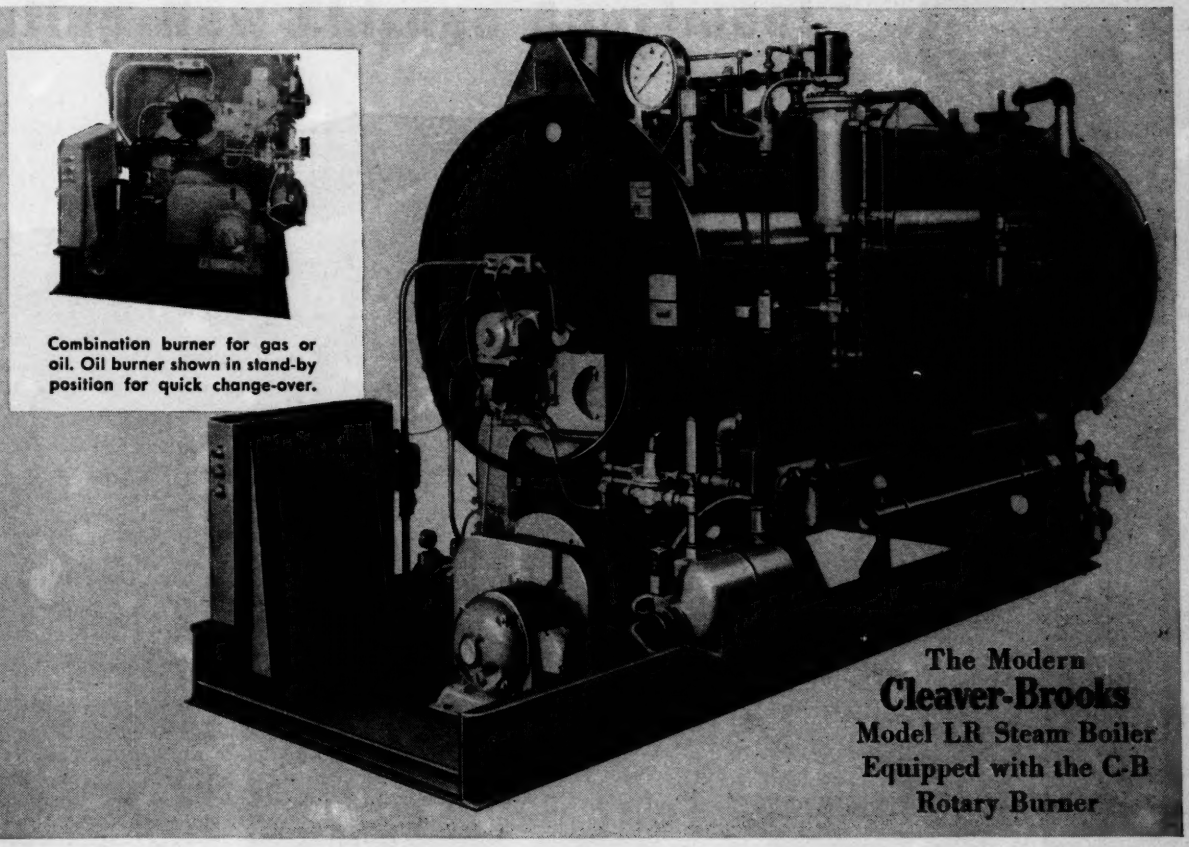
H. A. THRUSH & COMPANY • PERU, INDIANA

¾" • 1" • 1¼" • 1½"
1/6 HORSEPOWER

2" • 2½" • 3"
1/4 HORSEPOWER

THRUSH water circulators

unmatched Flexibility of operation ...and of quick fuel change-over



Combination burner for gas or oil. Oil burner shown in stand-by position for quick change-over.

The Modern
Cleaver-Brooks
Model LR Steam Boiler
Equipped with the C-B
Rotary Burner

✔ **Quick Steaming—Fast, effortless response to fluctuating steam demands**

✔ **Equally high efficiency using heavy No. 6 oils (or lighter oils) and all types of industrial gas**

IF the quantity of steam required in your plant fluctuates throughout the day, depending upon the amount of steam-using equipment in operation, you can cut your steam costs substantially with a Cleaver-Brooks Boiler. It operates at a full 80% guaranteed efficiency whether you require maximum load use of all steam-using equipment . . . or whether your equipment is not in use, requiring as little as 30% response — often just enough to heat the plant.

Install a Cleaver-Brooks Boiler — oil, gas, or combination — either fuel properly proportioned by the exclusive Cleaver-Brooks Burner to meet your fluctuating or constant steam demand. Fully automatic, clean, with a single source for all of its matched parts . . . you benefit with lower fuel bills, less maintenance, reduced operating costs, greater profits. Why not consider changing your present boiler plant and think of flexibility — remember Cleaver-Brooks and get the complete facts on boilers, 15 to 500 HP — 15 to 250 lbs. psi.

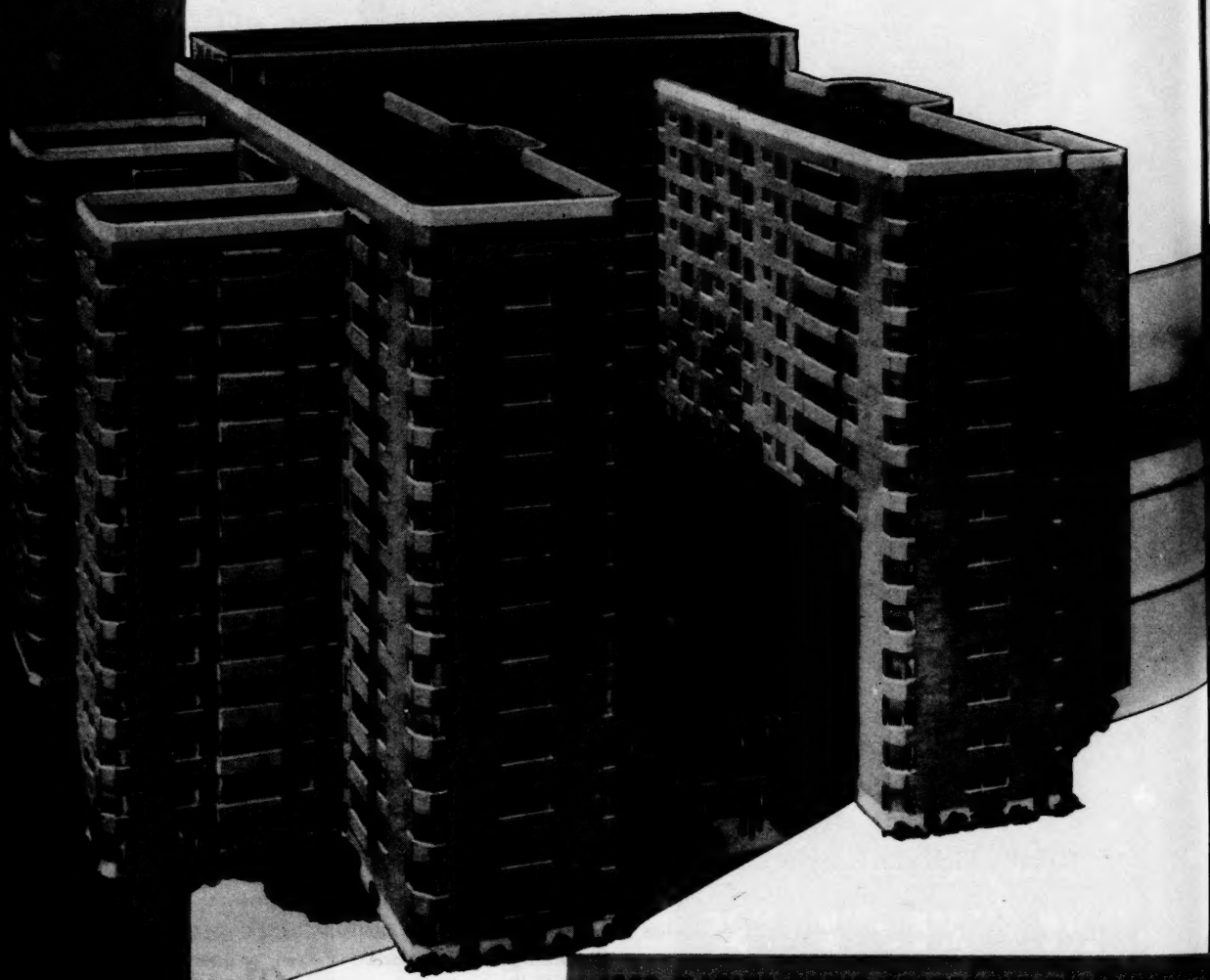
Write for latest, fully illustrated and descriptive Cleaver-Brooks Steam Boiler catalog.

Cleaver-Brooks
STEAM BOILERS
the first and finest of their class

CLEAVER-BROOKS COMPANY
Dept. F-314 E. Keefe Ave., Milwaukee 12, Wis., U. S. A.
Cable Address: Clebro-Milwaukeewis

Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

OVER 2



ARCHITECT—Dubin & Dubin, 140 North Dearborn, Chicago, Illinois.

ENGINEER—H. S. Nachman & Associates, 179 West Washington, Chicago, Illinois.

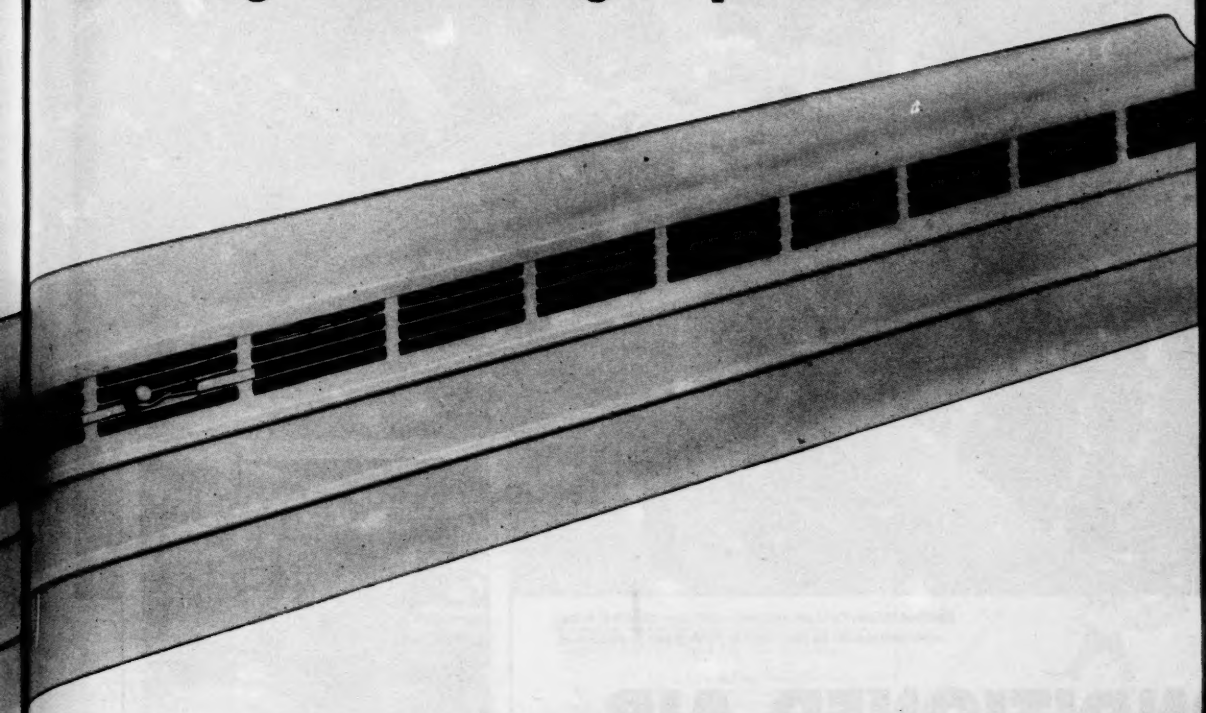
GENERAL CONTRACTOR—Peter Hamlin Construction Co., 9 South Clinton Street, Chicago, Illinois.

HEATING CONTRACTOR—Davis Construction Co., 18 West Kinzie, Chicago, Ill.

MILES of fedders

Baseboard Radiation

Heating New Chicago Apartment



Men who design and build modern American housing are turning to Fedders Baseboard Radiation for efficient, economical heating.

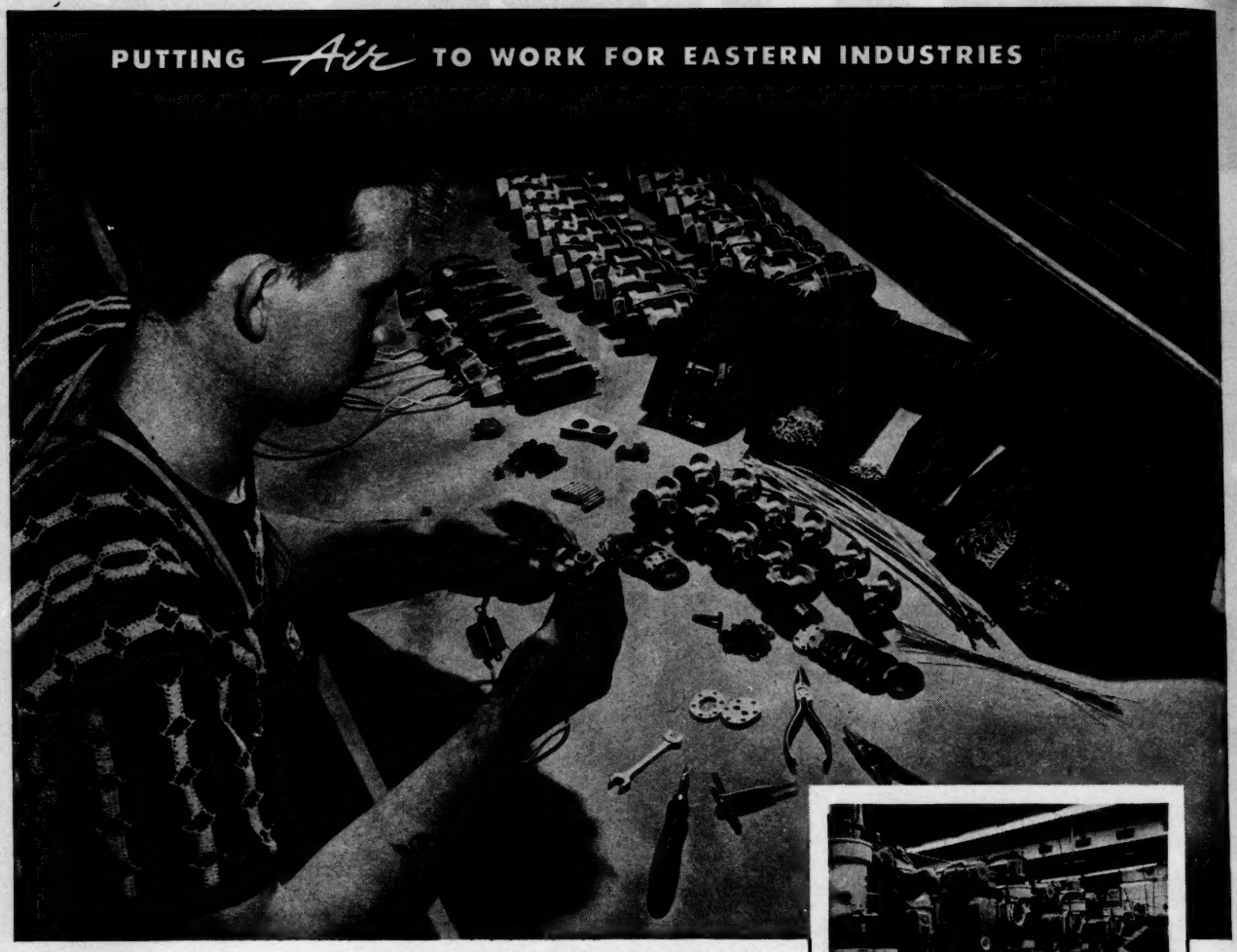
This ultra-smart apartment building located at 4950 Marine Drive is another example of how men of the profession and the industry are providing new comfort, new cleanliness and new decor with Fedders Baseboard Radiation.

Taking the place of ordinary baseboards, Fedders Baseboard Radiation saves space, facilitates furniture arrangement and simplifies picture window installations.

Fedders Baseboard Radiation has specially designed anti-streak covers (patent applied for) which reduce cleaning and maintenance costs.

They are light in weight, easy to stock and install. They give instant response to thermostatic control thus conserving fuel by eliminating necessity to "force the fire" or open windows to cool off. Fedders representatives are located in every major city. You will find their names in your classified telephone directory.

PUTTING *Air* TO WORK FOR EASTERN INDUSTRIES



Machined surfaces flat to one light band—that's one-millionth of an inch —are made possible the year 'round by Westinghouse air conditioning.

CONDITIONED AIR

HELPS WIPE A WINDSHIELD AT 30,000 FEET

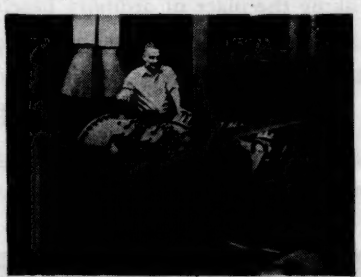
This midget motor-pump sprays a grease-removing solvent onto aircraft windshields. Another provides ground-level conditions for air-borne radar in the stratosphere. Eastern Industries *mass produces* both, but with *tool-room precision.* Critical dimensions are held to plus or minus 25 millionths of an inch! That just isn't possible in hot, humid air.

The answer? Westinghouse-conditioned air maintains plant-wide, controlled atmosphere for such exacting machining, assembling, testing and inspecting. Air conditioning and air cleaning assure a constant temperature and humidity the year 'round, help guard against the dirt, rust and corrosion that will upset delicate gauges or mar super-finished surfaces.

Your product, processes and employees will do better in Westinghouse engineered air. Let us help you *put air to work* for more production, higher quality or improved methods. Check the Yellow Pages for your local Westinghouse Air Conditioning Distributor, or write Westinghouse Electric Corp., Air Conditioning Division, Hyde Park, Boston 36, Massachusetts.

Ducts supply entire building with conditioned air for precision work like this gear cutting operation.

This electronic gauge is so sensitive that even your body heat can cause deflections in its readings.



Their 100 hp Westinghouse compressor is as foolproof as your refrigerator, will give years of service.

YOU CAN BE SURE...IF IT'S

Westinghouse

J-80248

Tap the ever expanding market for this greatest new heating of all

Ceiling radiant heating coils of Bundyweld® Tubing are quickly, economically installed, then plastered over to form *invisible* source of gentle, even radiant heat.

Absence of radiators and registers in room with Bundyweld ceiling radiant heating permits furniture arrangement that suits you best. Gone, too, are usual wall streaks and heavy dust deposits on furnishings.

Warm floors are a *feature* of the house with Bundyweld ceiling radiant heating. Its radiant rays, like the sun's radiant rays, are directed *downward*.

Bundyweld is the *only* tubing double-walled from a single strip. It's steel tubing, copper-coated inside and out. Leakproof, takes high pressures, transmits heat quickly.

Amazing warmth, cleanness, savings— yours with Bundyweld ceiling radiant heating

Going to remodel, build, or buy? Look into the exciting advantages of Bundyweld *ceiling* radiant heating right now. It's the most comfortable, most economical, cleanest heating of all, growing by leaps and bounds in today's housing.

Here is heating that truly *radiates* swiftly downward from the ceiling, gently warming all the room, with *even* temperatures from floor to ceiling. Here's heating so natural, fresh, and invigorating it's like having the sun in your ceiling.

Clean, economical, too

Draft-free Bundyweld ceiling radiant heating won't spread heavy dust layers over curtains, draperies, furniture. It won't cause hazy films on mirrors, dishes, and glassware. It shortens daily housekeeping chores. Too, Bundyweld ceiling radiant heating eliminates space-eating, wall-streaking radiators and registers; postpones wall washing and redecorating for years.

Bundyweld ceiling radiant heating costs little if any more to install than forced hot-air heat. In addition to reasonable first cost, it gives you continuing yearly home-maintenance economies and fuel savings that make it your lowest-cost heating of all in the long run. Most important, of course, the heating comfort is priceless. Get the *full* story. Send for free brochure at right.

BUNDY TUBING COMPANY
Detroit 14, Michigan ©B.T.C.
WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING

Get the *full* story before you decide on *any* heating system. Send for free brochure.

Fascinating, beautiful 20-page brochure gives you complete story of Bundyweld ceiling radiant heating. It takes you behind scenes, explains radiant heating clearly. Gives full story of tremendous advantages, answers dozens of questions, reports views and experiences of people who live with Bundyweld ceiling radiant heating. Send for your copy now.

Radiant Heating Division, Dept. B-5
Bundy Tubing Company
Detroit 14, Michigan

Send me free 20-page "Home Owner's Guide to Bundyweld Ceiling Radiant Heating."

Name_____
Address_____
City_____ Zone____ State_____

The boom is on for Bundyweld ceiling radiant heating, newest, most advanced heating method of all.

It's low in cost—often no more than forced-air heating and frequently less. It's easy to install, simple in operation, trouble-free.

Bundyweld ceiling radiant heating is one of the most talked-about house features today. Thousands upon thousands of prospective home owners are clipping coupons from ads like the one at left and sending them in to get information.

Home owners who live with it want nothing to do with any other heating. Builders and contractors who work with it know they have a good thing that's growing bigger every day.

Get the full story on the heating of today and tomorrow. Mail coupon today.

Radiant Heating Division
BUNDY TUBING COMPANY
Detroit 14, Michigan

Many of your prospects, among hundreds of thousands of others, have had their eyes opened by this Bundyweld ceiling radiant heating ad. It's the second in a 4-color, year-round series bringing news of today's fastest-growing, most advanced heating method to the readers of *Better Homes & Gardens* and *American Home*.

SEND FOR FREE LITERATURE! →

Send for Bundy's free 20-page brochure that explains Bundyweld ceiling radiant heating fully and clearly, gives views of people who live with it — including a heating engineer and a plumbing and heating contractor who work with it every day.

Radiant Heating Division, Dept. HV 552
Bundy Tubing Company, Detroit 14, Michigan

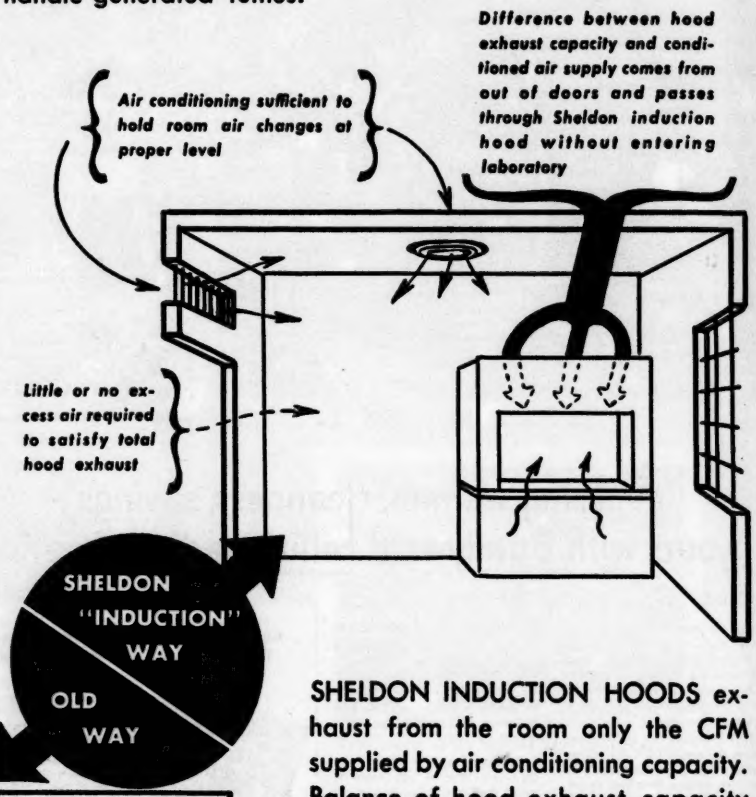
☐ Send me free 20-page consumer brochure on Bundyweld ceiling radiant heating.
☐ I would also like Bundy technical radiant heating bulletin.

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

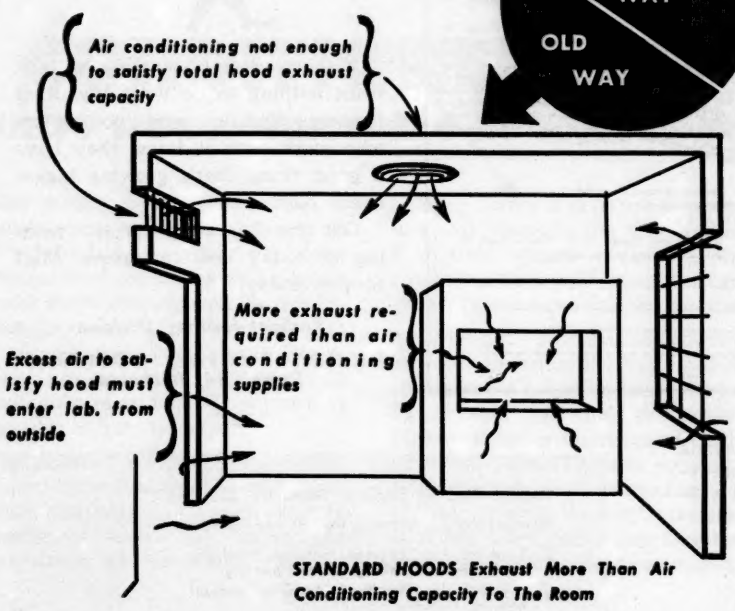
AIR CONDITIONED LABORATORY FUME DISPOSAL with SHELDON "INDUCTION" HOODS

SHELDON HOODS FOR CONSERVING ROOM AIR are designed to exhaust definite VOLUMES of air from the laboratory and hold the air changes within the room at predetermined levels. At the same time ample volumes of air pass thru the working area of the hoods to efficiently handle generated fumes.

SHELDON SELF VENTILATED OR INDUCTION HOODS operate efficiently under a ratio as low as ONE FOURTH of the volume of *room air* that standard hoods require. The balance of required air volume comes from the outside atmosphere and needs no conditioning. This reduces the conditioning load for both cooling and heating and makes practical air conditioned laboratories with large capacity fume hood installations at economical levels. For example: 12 linear feet of hood capacity will operate efficiently at as low as 600 CFM of air from the room whereas ordinary hoods using comparable volumes of air should draw 2400 CFM of room air.


Difference between hood exhaust capacity and conditioned air supply comes from out of doors and passes through Sheldon induction hood without entering laboratory
Air conditioning sufficient to hold room air changes at proper level
Little or no excess air required to satisfy total hood exhaust
SHELDON "INDUCTION" WAY
OLD WAY

SHELDON INDUCTION HOODS exhaust from the room only the CFM supplied by air conditioning capacity. Balance of hood exhaust capacity supplied by hood and does *not* enter laboratory and is *not* conditioned.


Air conditioning not enough to satisfy total hood exhaust capacity
More exhaust required than air conditioning supplies
Excess air to satisfy hood must enter lab. from outside

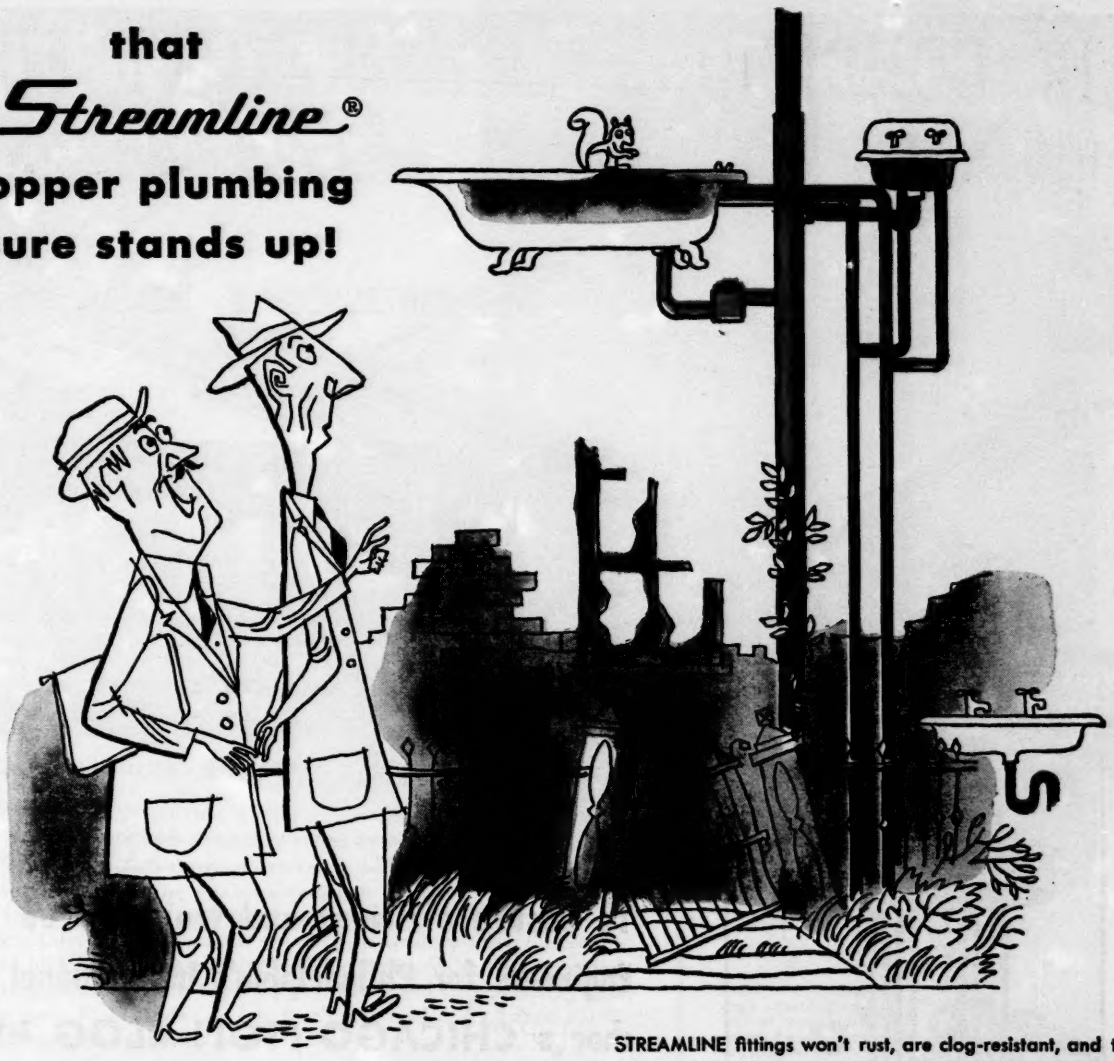
STANDARD HOODS Exhaust More Than Air Conditioning Capacity To The Room

SHELDON INDUCTION HOODS are adjustable to meet laboratory requirements. Our sales engineers will be glad to work with you on definite installation requirements. Write or wire Muskegon, Michigan, for the nearest sales office and engineer.

E. H. SHELDON EQUIPMENT COMPANY

MUSKEGON, MICHIGAN

that *Streamline*® copper plumbing sure stands up!



STREAMLINE solder type wrought copper fittings.

STREAMLINE fittings won't rust, are clog-resistant, and they can't be loosened by vibration. So when you install STREAMLINE solder type fittings, you can be sure you're installing a permanently reliable plumbing system that will last for years and years—even under the toughest conditions.

STREAMLINE wrought fittings are easy to install because they are light in weight . . . dimensions are accurate . . . and because solder joints are the same uniform depth to make it easy to compute the tubing length. By reducing handling time, STREAMLINE fittings increase the number of jobs you, as a contractor, can handle.

STREAMLINE fittings provide an attractive, snug-fitting system that tests leakproof on the first try and won't develop leaks later. Next time you install a plumbing, air conditioning or industrial system, be sure it's a STREAMLINE system.

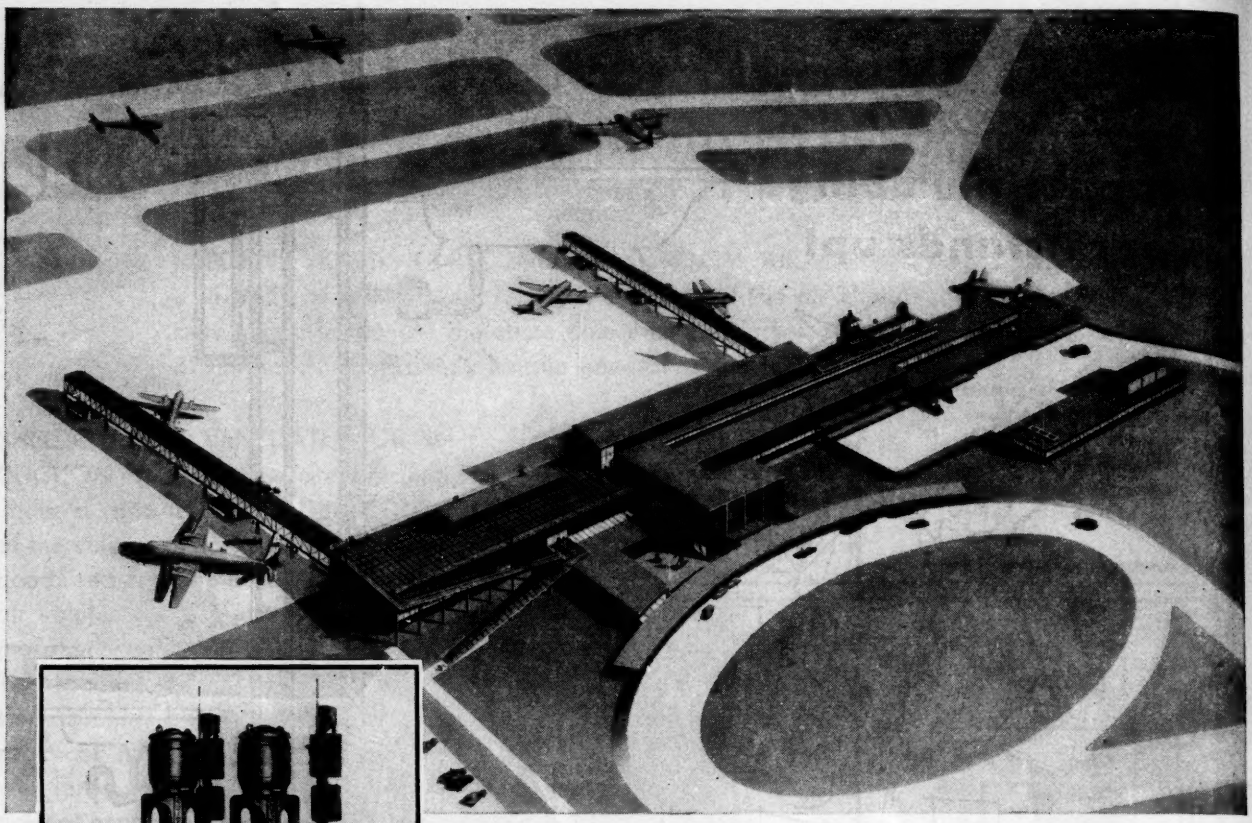
STREAMLINE threaded cast bronze fittings.

See your jobber for further information or write for catalog S-352 describing our complete line of STREAMLINE wrought copper and cast bronze fittings.

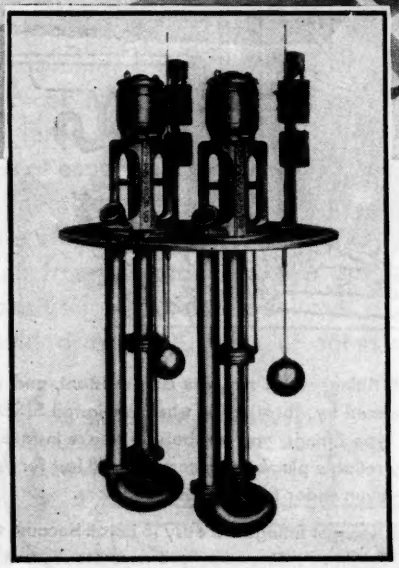
76

MUELLER BRASS CO STREAMLINE PRODUCTS

MUELLER BRASS CO. PORT HURON 2, MICHIGAN



Carroll, Grisdale & Van Alen, Architects
A. E. D'Ambly, Structural Engineer — L. E. Winter & Company, Contractor



To assure efficient and trouble-free service Engineers for Philadelphia's International Airport choose CHICAGO NON-CLOG PUMPS

—14 DUPLEX SETS—

In selecting the sewage and sump pumps for Philadelphia's Airport Terminal Chicago Non-Clog Pumps were specified. The large volume of traffic with heavy peak loads at arrival and departure time made it essential that reliable, heavy duty pumps be used. The Chicago Non-Clog with a background of 43 years of rugged dependable service, was the logical choice. 28 pumps, in basins of 14 duplex sets, pump the sewage and bilge from this new and modern airport terminal.

Philadelphia's great new international airport is one of the finest in the world. The modern terminal building incorporates the latest in design and lay-out for easy and efficient handling of passenger traffic.

In planning the structure, the architects wisely provided for future growth. At the present rate of expansion it is expected that by 1960 about 613,000 passengers per year will use the terminal. Both at present and with this expected volume of traffic, Philadelphia's airport will rank among the first 20 in the country, both as to number of planes and number of passengers using the airport. Carroll, Grisdale & Van Alen, Architects. A. E. D'Ambly, Structural Engineer. L. E. Winter & Company, Contractor.

CHICAGO INDUSTRIAL PUMPS

CHICAGO PUMP COMPANY

BUILDING and INDUSTRIAL DIVISION

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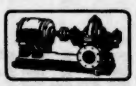
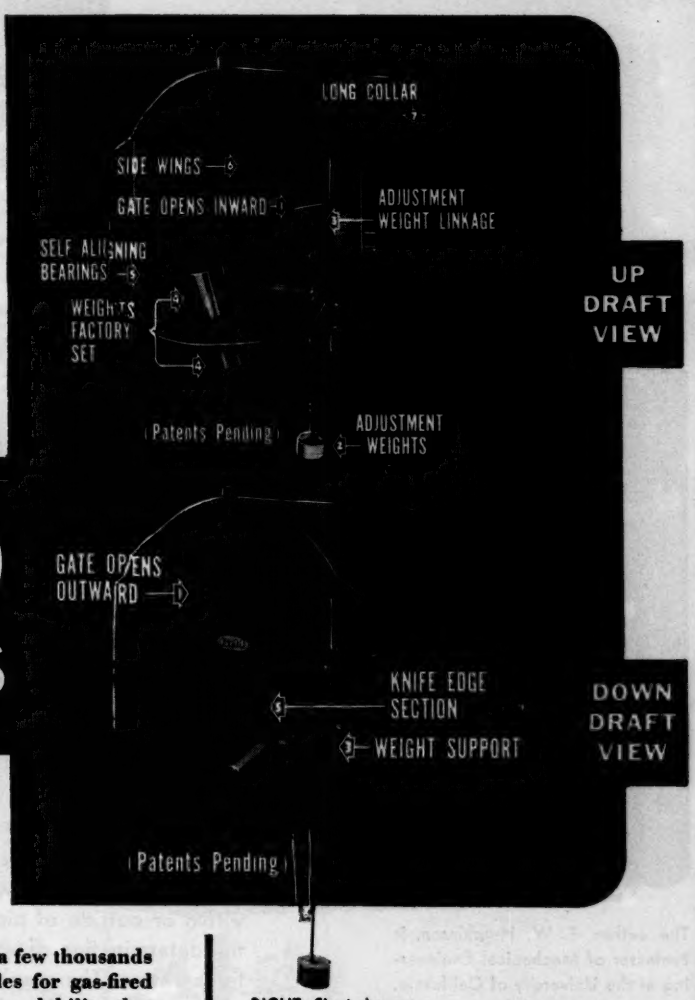
Condo-Vac, Sure Return. AVC, LVC, Fire, House & Circulating Pumps Pneumatic & Tankless Water Systems.



Flush-Kleen Sewage Ejectors Little Giant & Non-Clog Bilge Pumps Pumps for every industrial use.

Now ... a Field BAROMETRIC DRAFT CONTROL FOR COMMERCIAL & INDUSTRIAL

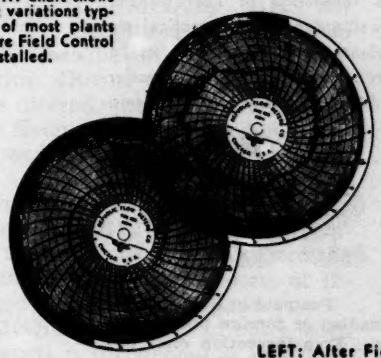
GAS FIRED HEATING PLANTS



(Not yet available in domestic sizes)

The Field "M-G" Double Acting Draft Control brings greater efficiency, greater economy to gas fired heating plants through extremely accurate control of drafts. The double-acting gate opens inward to regulate up-drafts, and outward to relieve internal or down-draft pressures as small as a few thousands of an inch. This newest Field Draft Control provides for gas-fired heating plants the same accuracy, sensitivity and dependability that have made Field Draft Controls first in the coal and oil-fired fields. Write today for detailed specifications.

RIGHT: Chart shows draft variations typical of most plants before Field Control is installed.



LEFT: After Field Control installation the breeching draft is held constant.

FIELD CONTROL DIVISION

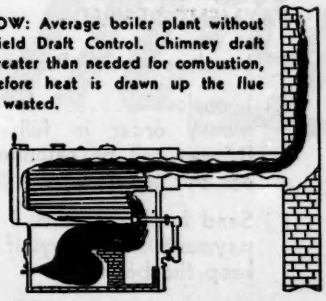
of H. D. Conkey & Company, MENDOTA, ILLINOIS

SEE OUR DISPLAY BOOTH 152, OIL HEAT INSTITUTE CONVENTION, PHILADELPHIA.

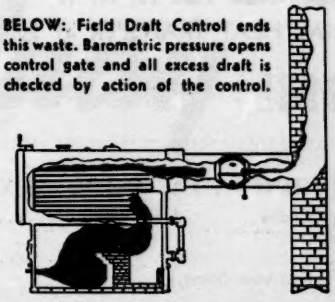
In case of prolonged down draft or blocked flue, an optional auxiliary switch can be mounted on the control and wired to shut off the burner, thus providing protection against the escape of carbon monoxide into the building.

Why a Field Draft Control:

BELOW: Average boiler plant without a Field Draft Control. Chimney draft is greater than needed for combustion, therefore heat is drawn up the flue and wasted.

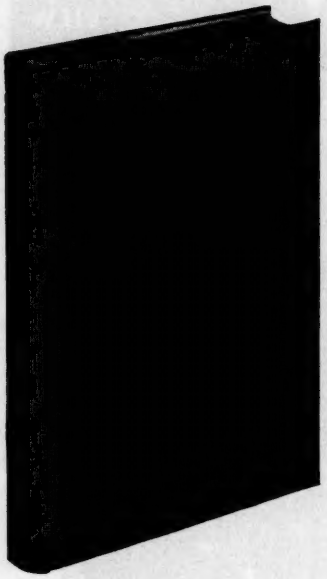


BELOW: Field Draft Control ends this waste. Barometric pressure opens control gate and all excess draft is checked by action of the control.



CONTROLLED DRAFT BY **Field** BAROMETRIC CONTROLS

Time-Saving Working Charts Speed Solution of Heat Transfer Problems



The author, F. W. Hutchinson, is Professor of Mechanical Engineering at the University of California. His knowledge of heat transfer is well-grounded on practical experience as well as theory, as he acts as consultant on heat transfer problems for many industrial firms.

336 Pages

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A Combined Text and Reference Book for the Practicing Engineer as well as the Student of Heat Transfer

INDUSTRIAL HEAT TRANSFER, by F. W. Hutchinson, provides a selective, time-saving approach to methods of heat transfer analysis. It presents and discusses equations finding the widest industrial application, analyzes their derivation, and then brings the subject to an eminently practical conclusion by providing graphs which permit direct visual solution of the most commonly encountered problems. The 123 working graphs are equal in accuracy to the equations from which they are derived, thereby saving time and reducing the possibility of error in making calculations.

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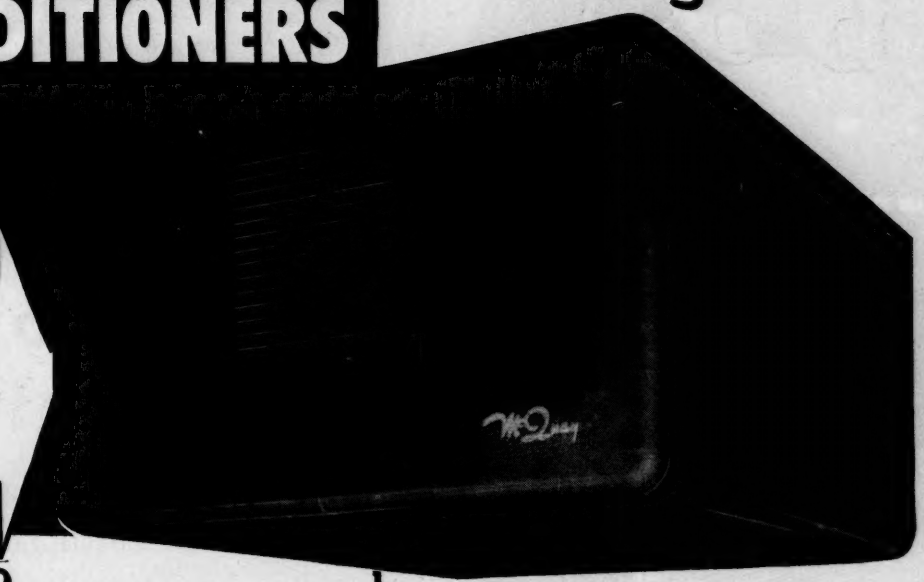

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Individual Room Air Conditioners for year 'round service.
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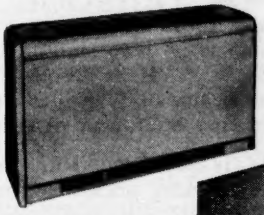
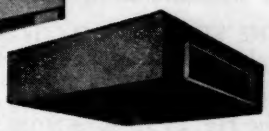


Floor Type. For free standing mounting beneath a window or along a wall.



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Also available in basic type for fully recessed installation.

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The McQuay "RH" Air Conditioner leads the field for efficient, economical cooling and heating. During hot weather, fresh outside air is filtered, then cooled by either cold water or freon coils. Steam or hot water coils provide warm filtered air for the heating seasons.

For modern shops, stores, offices, beauty parlors, restaurants and taverns, it's a streamlined beauty that can be suspended from the ceiling, mounted on existing fixtures, or installed adjacent to conditioned space.

Famous McQuay Ripple-Fin coils with rugged construction throughout assure long dependable service—and customer satisfaction. In 4 sizes to fit a wide range of requirements. Write for catalog No. 97. Representatives in principal cities. McQuay Inc., 1619 Broadway St. N.E., Minneapolis, Minn.

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KENNEDY bronze gate valves...

JOB-FITTED for low-cost maintenance

KENNEDY FIG. 27, Bronze Gate Valve
125 lbs. steam, 200 lbs. WOG, non-shock

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TO ASSURE DEPENDABLE OPERATION with minimum maintenance, the complete KENNEDY Line is *job-fitted* . . . every valve specially designed and engineered for the job it has to do.

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EXTRA TIGHTNESS, without undue wear on the packing, is assured by an unusually deep stuffing box. Stripping of the stem and disc threads is practically impossible. Ribs cast on inside of valve body fit into channels in disc to maintain straight-line operation of all moving parts.

THE STUFFING BOX is provided with gland, and the valve can be repacked under pressure when wide open.

SCREWED BONNET AND WEDGE DISC are standard on the Fig. 27 in sizes from ¼ to 3 inches. Larger sizes are constructed with bolted bonnets and cam-type double discs with parallel seats. Working pressures ¼" thru 3": 125 lbs. Steam, 200 lbs. WOG, non-shock. 3½" thru 6": 100 lbs. Steam, 150 WOG, non-shock.

TO SAVE TIME AND TROUBLE, the Fig. 27 is *job-fitted* for easier installation, too. Wide, heavy pipe-end hexes have generous chamfer and precision threading . . . help you make tight connections quickly and easily.

FOR BEST RESULTS and real economy, standardize on KENNEDY Bronze Valves . . . and the complete line of KENNEDY Iron Valves, Malleable, Cast-Iron and Bronze Pipe Fittings.

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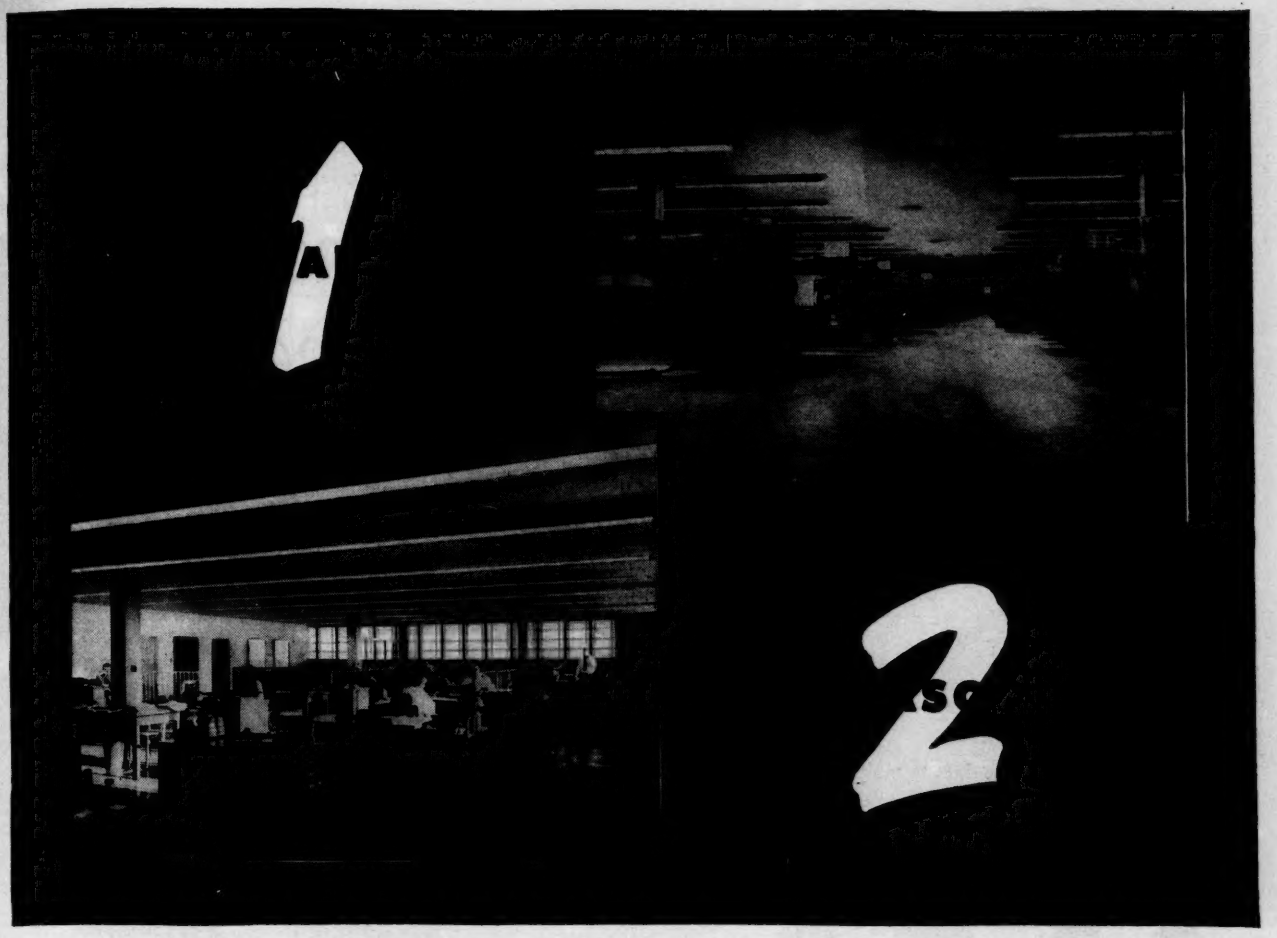

for choosing **kno·draft** adjustable air diffusers

Office space and manufacturing areas in this new asbestos dryer felt plant posed separate problems in air conditioning. In the manufacturing section, the vital factor in diffusion was the *even distribution* of the thoroughly conditioned air. Kno-Draft *Adjustable* Air Diffusers got the call because of their demonstrated efficiency in similar critical installations.

In offices and other employee quarters, beauty as well as efficiency had to be considered. Here again, Kno-Draft *Adjustable* Air Diffusers were selected. In addition to their unobtrusive harmony with any surroundings—from severely plain work areas to paneled directors' rooms — they assure the comfort of *draftless* air distribution.

Another big reason for choosing Kno-Draft *Adjustable* Air Diffusers for every job is their adjustability *after* installation. This means exactly the right balance of temperature and air distribution throughout the area for user comfort . . . and saves engineer and installer a vast amount of preliminary figuring. There are types and sizes of Kno-Draft *Adjustable* Air Diffusers to meet all requirements.

NEW EDITION! KNO-DRAFT DATA BOOK now in new 32-page format. Complete up-to-the-minute engineering and installation data on Kno-Draft *Adjustable* Air Diffusers. Bring your files up to date. Mail coupon today.

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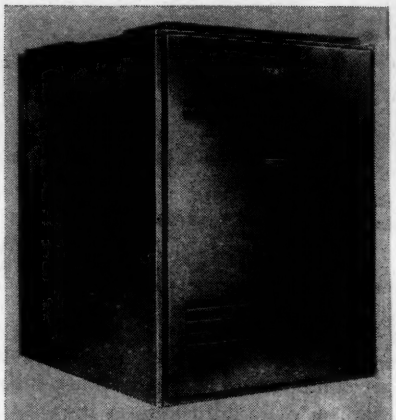
"Customer reaction clinched the No. 1 performance spot for this unit"

says P. V. Cheli,

Bryant, Chicago Branch Manager

It's too easy these days to make *claims* about any product. And it's mighty tempting to cut prices at the expense of quality, too. Personally, I judge *heating* equipment strictly on performance and the reactions I get from my customers. In the case of the Bryant Forced Warm-Air Furnace, customer reaction has certainly proved this unit is the star in its field. Actually this isn't any surprise at all, because the basic engineering and construction that have been put into the Bryant Model 87 have produced advantages that are unsurpassed in any other warm-air unit. Consider, for example, the enviable record for reliability and economical operation that Bryant Controls and Automatic Pilot have built up. And don't forget the Bryant *Hevigage* (12-gauge steel) heat exchanger . . . rugged . . . designed for the fastest and most efficient heat transfer. Almost three times thicker than minimum AGA requirements, too. If you're not already acquainted with the features and performance of this popular Bryant unit why not get a firsthand story from some Bryant customers. Or write Bryant Heater direct for complete information. Bryant Heater Division, Dept. 142, Affiliated Gas Equipment, Inc., 17825 St. Clair Ave., Cleveland, Ohio.

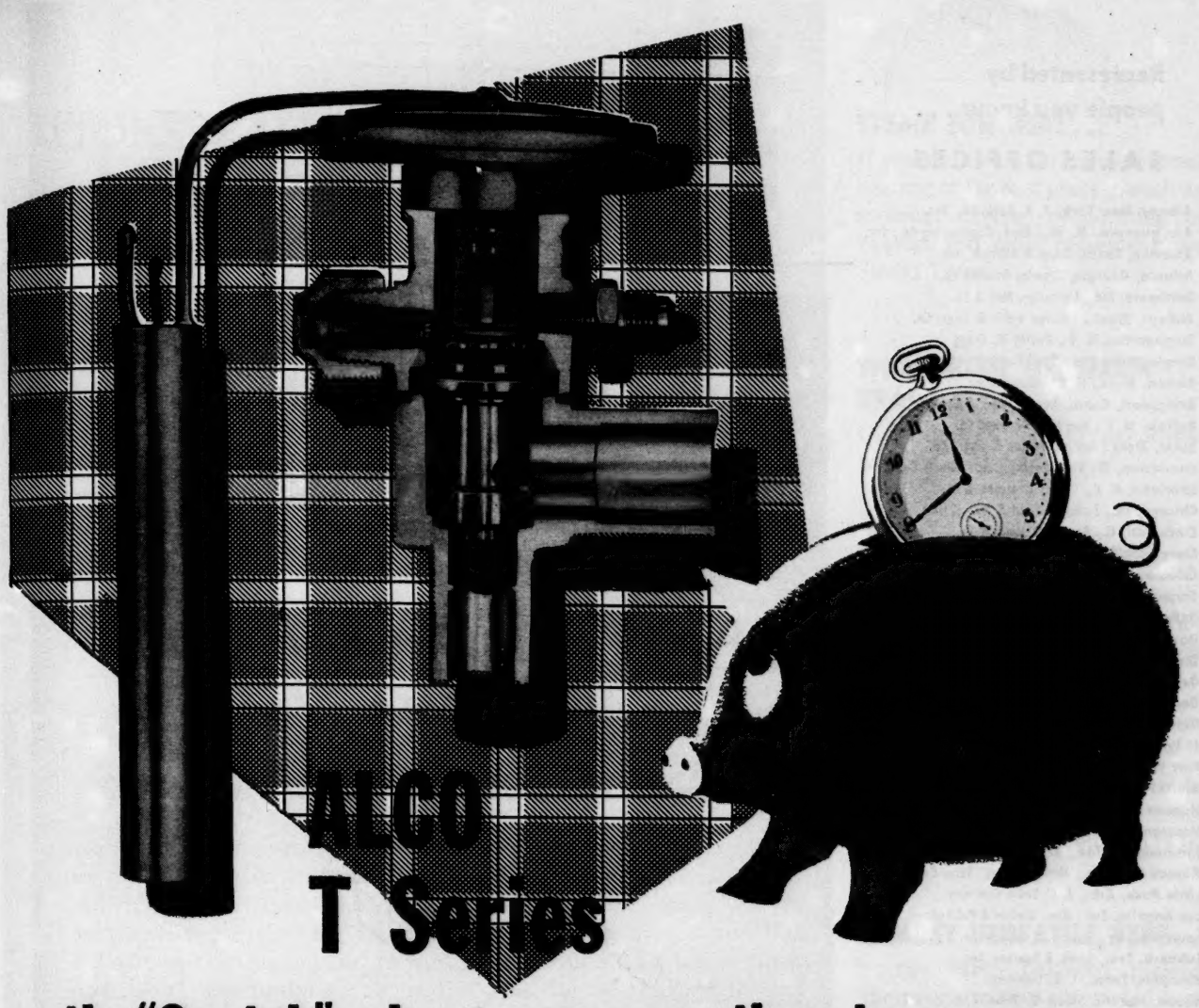


Bryant Model 87
Winter Air Conditioner

Gas-fired, forced warm-air furnace. Available for all gases. AGA inputs from 60,000 to 375,000 Btu per hour. Has *Hevigage* (12-gauge steel) heat exchanger. Sturdy, compact construction. Handsome gray exterior.

bryant *best buy*

IN HEATING,
AIR CONDITIONING,
WATER HEATING



the "Scotch" valves—save you time two ways

EASY TO SERVICE ON THE LINE—remove two cap screws; lift off power assembly; take out the cage assembly. Now you're ready to inspect and clean the valve or replace parts.

EXTERNAL SUPERHEAT ADJUSTMENT—just remove seal cap on side of the valve and turn adjusting stem. It's that simple!

Available with internal or external equalizer. Capacity from 1/2 to 50 tons "F-12". There is a T-Series Valve for all temperatures and all refrigerants.

For further details, send for Bulletin 171.

SEE YOUR ALCO WHOLESALER!

ALCO

ALCO VALVE CO.

859 KINGSLAND AVE. • ST. LOUIS 5, MO.

Designers and Manufacturers of Thermostatic Expansion Valves; Evaporator Pressure Regulators; Solenoid Valves; Float Valves; Float Switches.

5156

Represented by people you know . . .

SALES OFFICES

Albany, New York, F. R. Foote Co., Inc.
Albuquerque, N. M., Boyd Engineering Co., Inc.
Amarillo, Texas, Snook & Aderton, Inc.
Atlanta, Georgia, Crawley-Gorbant Co.
Baltimore, Md., Lancaster, May & Co.
Billings, Mont., Sullivan Valve & Engr. Co.
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Boston, Mass., L. R. Geissenhainer
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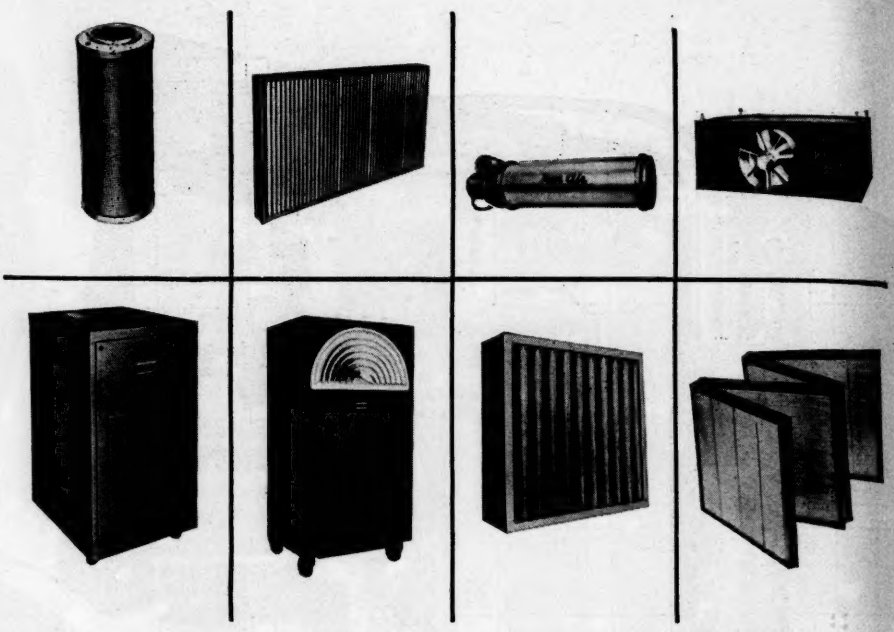
West Hartford, Conn., Augur, Jones & Green
Wichita, Kansas, J. M. O'Connor Co.



Purify air and remove odors with *Pur Air* activated, coconut-shell carbon

Where odor removal is a problem, Pur Air equipment can supply the answer . . . in duct systems, with fixed-mount installations or portable units. 35 years of testing over 15,000 materials proved that activated carbon made from coconut shells had the greatest adsorptive qualities for air purification. In Pur Air equipment you get ONLY true Activated, Coconut-shell Carbon . . . no substitutes. The carbon does the job, and in Pur Air equipment you get plenty of ACSC*. Quality control is assured, because Pur Air is the only manufacturer that both produces activated, coconut-shell carbon and builds the equipment, too.

Pur Air equipment for all applications

For air intake and air recirculation ducts the adsorber plates, filter fold, partial-air-by-pass or canisters are used. Portable units are used in conference rooms, hospital wards, etc. . . . fixed mount in industrial areas and cold storages. The Fresh'ner is ideal for small rest rooms and dressing rooms.

For detailed information phone our nearest office (listed at left) or write direct.

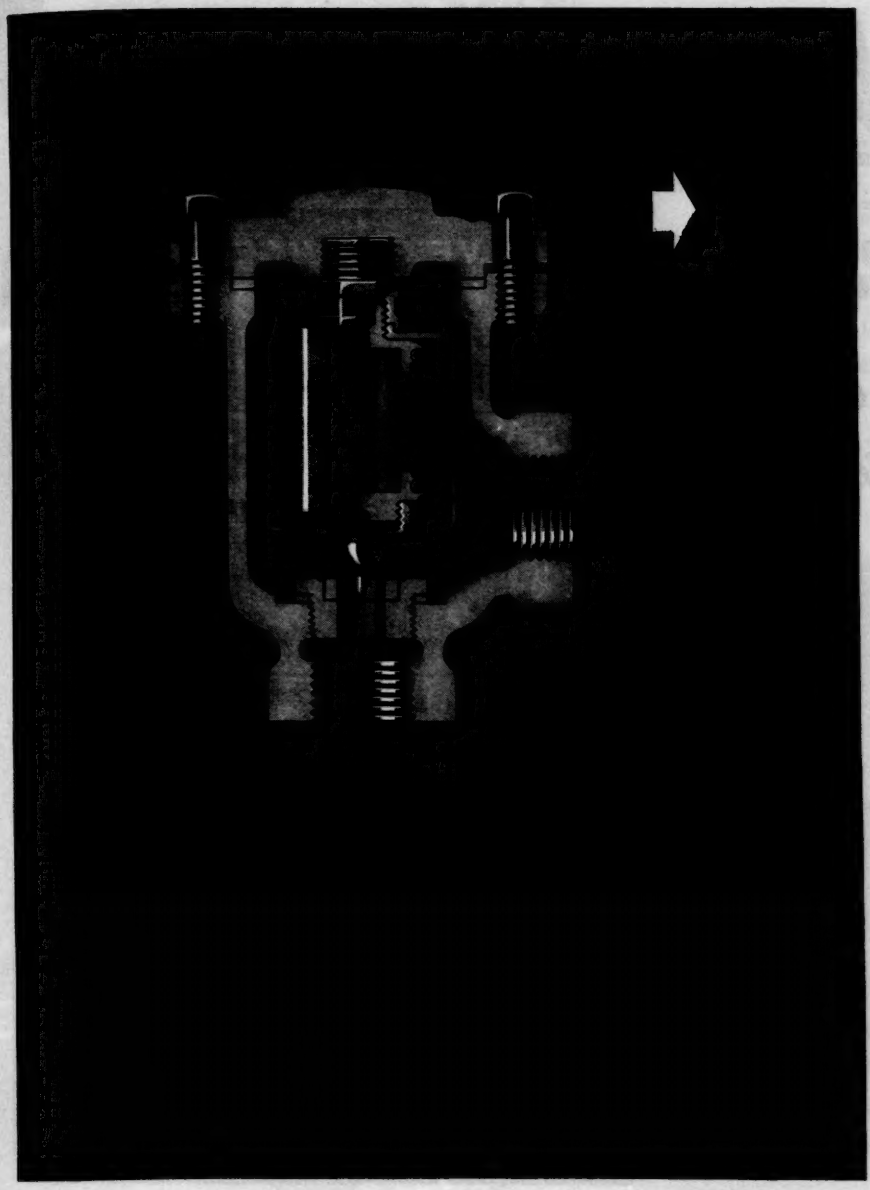
*ACSC: activated, coconut-shell carbon.

Pur Air

a division of **AMERICAN SOLVENT RECOVERY CORP.**

COLUMBUS 3, OHIO

WORLD'S LARGEST **PRODUCER OF GAS-ADSORBENT CARBONS**



STEAM FOR HEAT...

If you use steam for room or space heating or for any process, such as cooking, drying, evaporating or baking, you must necessarily use Steam Traps.

WHAT KIND OF STEAM TRAP?...

Of the many different types offered which should you choose?

SARCO MAKES 4 TYPES...

and can fit the trap to the job. We can give you unbiased advice, based on 30 years' field experience.

GIVE US FULL DETAILS...

on your trapping problem and let us pick the best type of steam trap for you, and tell you why.

A MOST VERSATILE TYPE...

is the Sarco balanced pressure thermostatic trap illustrated here.

It is suitable for most process steam applications and has many outstanding advantages.

AMONG SPECIAL FEATURES ARE:...

Only one moving part—the Sarco flexible bellows made of phosphor bronze, stainless steel or monel metal for maximum resistance to fatigue and corrosion.

No seats to change when pressures change—No protection required against freezing. Unequalled capacity for air removal.

Highest Discharge Capacity Per Dollar Cost

364

Write for New Bulletin No. 250-9

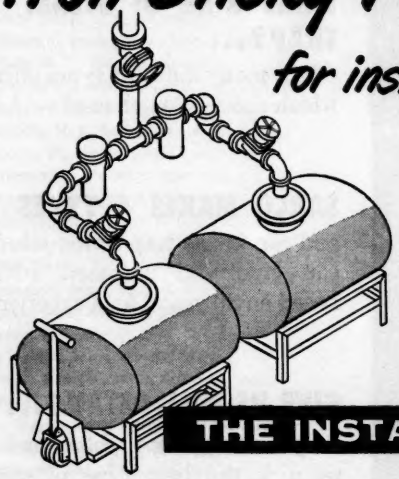
SARCO COMPANY, INC.

EMPIRE STATE BUILDING, NEW YORK 1, N. Y.
SARCO CANADA LTD., TORONTO 8, ONTARIO
REPRESENTED IN PRINCIPAL CITIES

Do Your Valves Fit Your Job This Well?

... on Sticky Fluid

for instance



THE INSTALLATION

Crane Diaphragm Valves on air pressurized liquid latex piping service in paint factory, Adams & Elting Division, The Glidden Company, Chicago.

VALVE SERVICE RATINGS

OPERATION:
Easy - No sticking

SUITABILITY:
Fluid can't get into bonnet

MAINTENANCE COST:
None to date - None indicated

SERVICE LIFE:
No sign of wear

OPERATING RESULTS:
Production delays stopped

PRICE:
In line - No premium

AVAILABILITY:
Stock item in Crane line

THE HISTORY

Conventional valves formerly used in this service were hindered by exposure of working parts to the line fluid. The sticky latex would accumulate in the bonnet and stem threads, freezing the stem, and making valve operation difficult or impossible. With 10 or more operating cycles required daily, the plant faced considerable valve trouble and maintenance expense.

Both trouble and maintenance cost were completely eliminated by replacing with Crane Diaphragm Valves. Their fully sealed bonnet keeps the latex out of working parts. They operate smoothly and do not freeze or stick. So well is the customer satisfied with Crane Diaphragm Valves, more have been ordered for new latex lines.

THE VALVE

Crane No. 1610 Iron Body Packless Diaphragm Valves featuring separate disc and diaphragm. Neoprene diaphragm acts as bonnet seal only; isn't pinched or stressed when valve is closed. Conventional type seating makes positive closure even should diaphragm fail. High flow capacity Y-pattern body has non-restricting interior design. Available unlined or fully Neoprene lined. Consult your Crane Catalog or Crane Representative.

The Complete Crane Line Meets All Valve Needs. That's Why
More Crane Valves Are Used Than Any Other Make!

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

LADISH

Controlled Quality

PIPE FITTINGS

reduce piping assembly time

Makeup goes smoother... with less chance for delay... on those piping systems where Ladish fittings are installed. Ladish Controlled Quality makes the difference. By exacting controls over materials and manufacturing processes... Controlled Quality assures uniform weldability through metallurgical integrity, fast assembly through dimensional accuracy and provides a real assurance of ultimate operating economy and complete dependability... reasons why it pays to specify LADISH.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
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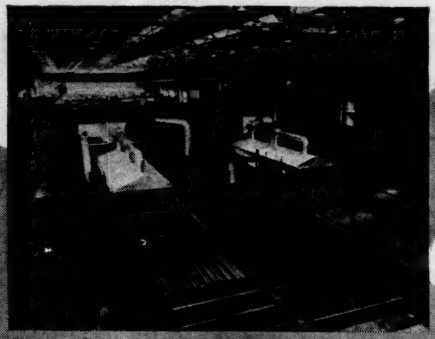
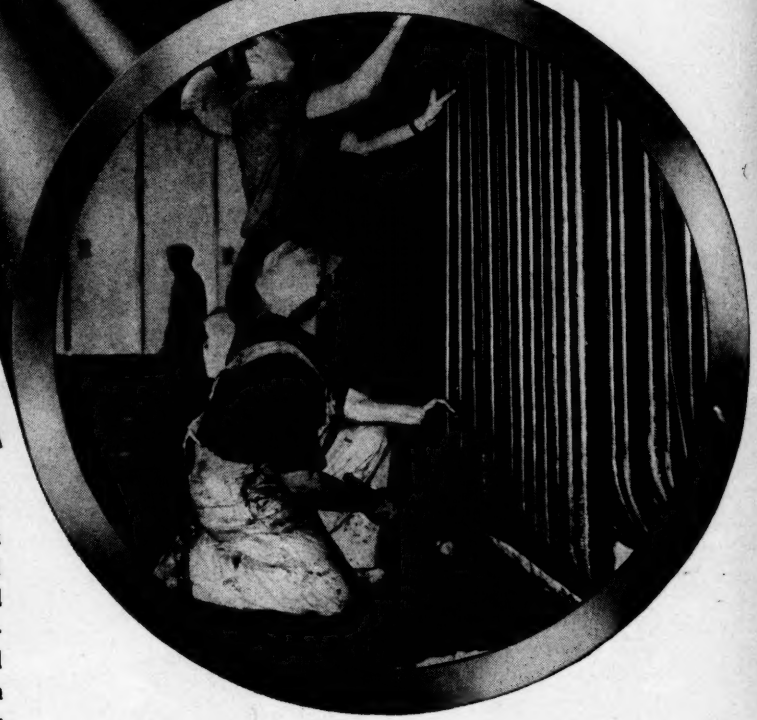


say B&W before you say WELDED Boiler Tubes

...for 5-star satisfaction*



★ quality
★ dependability
★ economy
★ uniformity
★ long service

When you specify B&W Electric-Resistance-Welded Boiler Tubes, you get 5-Star Satisfaction that goes beyond code requirements—plus values derived from metallurgically controlled materials, manufacturing precision, verified uniformity and meticulous inspection for perfection. Find out from Mr. Tubes—your B&W representative—or your local distributor what B&W 5-Star Satisfaction can mean to you, or write for information on B&W ERW Boiler Tubes.

B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION

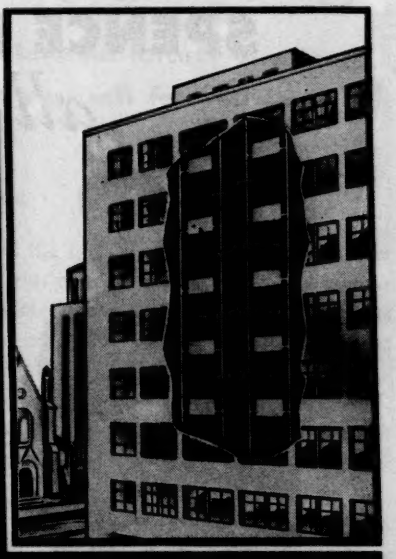
General Offices & Plants
Beaver Falls, Pa. — Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio — Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. Cleveland 14, Ohio • Denver 1, Colo. • Detroit 26, Mich. • Houston 2, Texas Los Angeles 17, Cal. • New York 16, N. Y • Philadelphia 2, Pa. St. Louis 1, Mo • San Francisco 3, Cal. • Syracuse 2, N. Y. Toronto, Ontario • Tulsa 3, Okla.

TA-1674C

NOW... a new remote type room air conditioner for multiple installations

THE REMOTAIRE BY AMERICAN-Standard

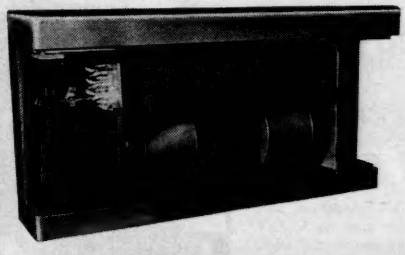


HEATS IN WINTER

COOLS IN SUMMER

PROVIDES CLEAN, FRESH AIR ALL YEAR 'ROUND

Designed for simplified economical installation in both old and new buildings



The new Remotaire is a remote type room conditioner providing all-weather air conditioning for multi-room installations such as hotels, apartments, office buildings, hospitals, residences and motels. It permits individual weather control for each room without affecting adjoining spaces.

The Remotaire uses chilled or heated water supplied through a simple piping system. And since ventilation air is introduced separately to each space, noise and odor transmission between rooms is eliminated.

Ease of installation is a major feature of the Remotaire. Spacious end sections provide plenty of working space; coil is designed for either right or left hand connections; fans and motor are on single mounting plate; and four standard control packages are available.

Be sure of all-weather comfort by specifying and installing efficient Remotaire units. Write for literature. **American Radiator & Standard Sanitary Corporation,** Dept. HV-52, Pittsburgh 30, Pennsylvania.

AMERICAN-Standard

HEATING-COOLING

American-Standard Products

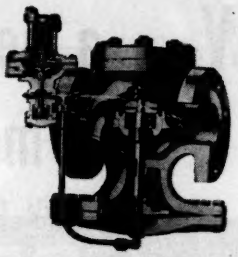
Serving home and industry

Looks like we're using
SPENCE REGULATORS
all over our plant

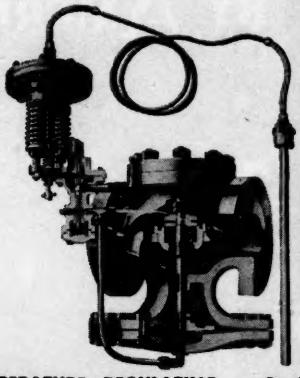
This busy plant has ordered and re-ordered Spence Regulators for two good reasons. (1) Spence offers a *wide-range line* to handle a host of regulating jobs. (2) What's more, Spence units give accurate service year after year. Maintenance is negligible. Over-all costs are low. These design features explain why . . .

- **Single Seat Packless Construction**
- **Large Balanced Metal Diaphragm**
- **Sensitive Pilots**
- **SECO Metal Seats and Discs**
- **Springs out of path of steam**
- **No dismantling for inspection**

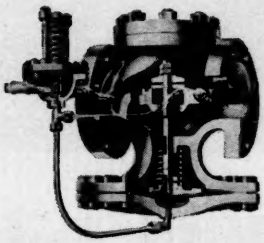
Write for Bulletin 350 for complete details on Spence's line of automatic regulating valves.



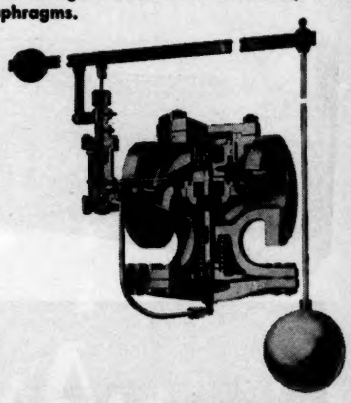
PRESSURE REDUCING—Self-operated, dead-end regulators powered by large, frictionless, metal diaphragms. Sizes 1/4 in. to 12 in. Pressures to 600 psi 750F.



TEMPERATURE REGULATING — Combined temperature and pressure control. No separate reducing valve required. Shuts tight, will not wiredraw or be damaged by overheating. Sizes to 12 in.



BACK PRESSURE CONTROL—Wide selection of sensitive pilots to meet exacting requirements. Initial pressure closing, guaranteed to shut tight. Packless construction, metal diaphragms.



LEVER OPERATED—Pilot lever for connection by cable or mechanical linkage to floats or other devices. Slight actuator motion opens and closes main valve.

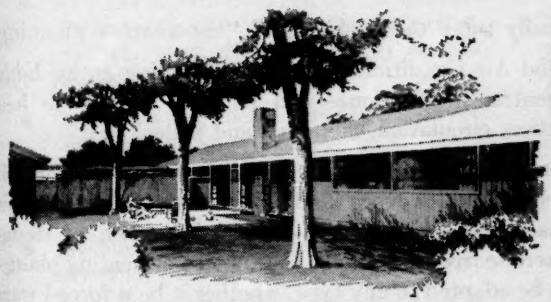
SE 116

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

Spence

This house sells air conditioning

This is a Carrier Weathermaker Home. It is built to take advantage of air conditioning. It gives the buyer better living. It can sell for you.



The architects—Carroll, Grisdale & Van Alen is a well-known Philadelphia firm whose recent work includes the Youth Study Center on Benjamin Franklin Parkway and the Terminal Building, Philadelphia International Airport (now in progress).

The Carrier Weathermaker

is designed for a duct system like that used for forced warm air heating. The Weathermaker cools and heats. It burns gas for heating . . . uses a sealed electric refrigerating unit for cooling. It is only a little larger than an ordinary furnace.

better value

When you sell the new Carrier Weathermaker Air Conditioner, you can give your buyer the advantages of a Weathermaker Home. You can give him more usable space per building dollar because in a Weathermaker Home rooms need only one exposure. Windows aren't needed on every wall. Movable sash isn't required. The floor plan can be a simple rectangle.

lower price

When you sell the new Carrier Weathermaker Air Conditioner for a Weathermaker Home, you can give the buyer a better price . . . and you can assure him of lower operating costs. The buyer won't need as much air conditioning capacity — because he can set and forget his air conditioning. And the Weathermaker Home is designed to reduce the heat load — and operating costs.

more profits

When you sell the new Carrier Weathermaker Air Conditioner for a Weathermaker Home, you're selling an exclusive. And you're selling an exclusive that gives the buyer extra benefits. You can demonstrate that he can have a better home. You can demonstrate his money savings. Isn't that the kind of deal that you'd like to be in on? Then write today!

Carrier

AIR CONDITIONING • REFRIGERATION

For 50 years—the people who know air conditioning best

CARRIER CORPORATION
306 South Geddes Street, Syracuse, N. Y.

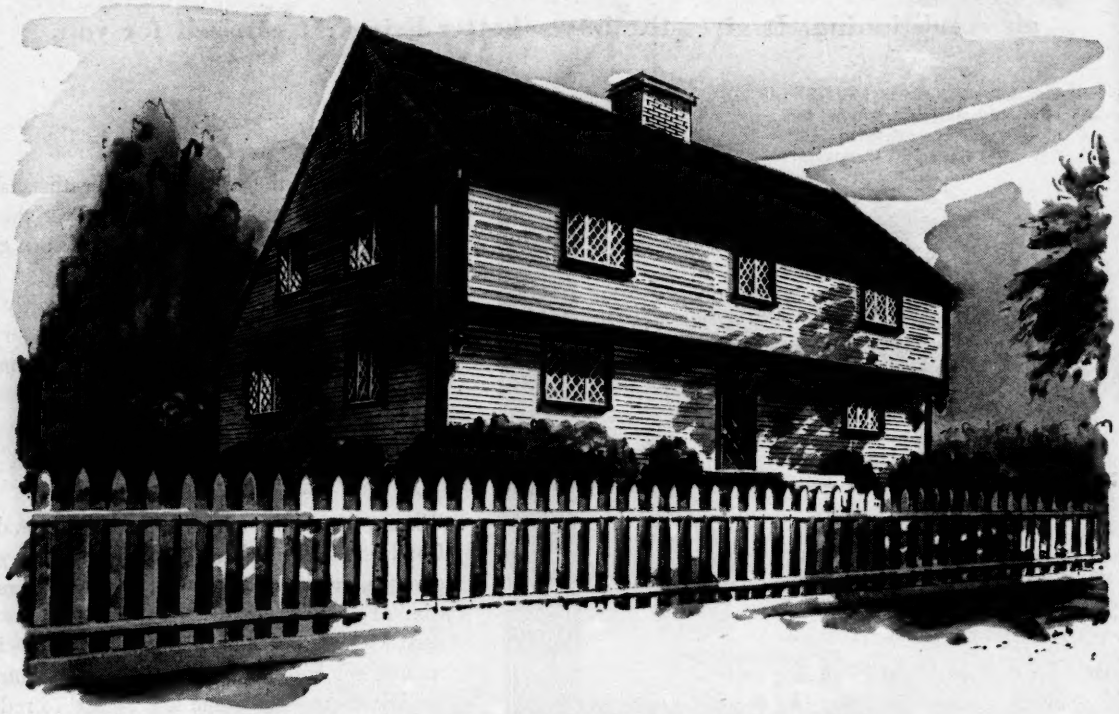
Please send me the profit story on the Weathermaker Air Conditioner and the Weathermaker Home.

*Name*_____

*Street*_____

*City*_____ *State*_____

CLIMATE DICTATED THIS HOUSE



Now You Can Dictate the Climate With YORK RESIDENTIAL AIR CONDITIONING

Only YORK Gives You All 8

- **Faster Cooling!** Unique Cooling Maze Coil cools and dehumidifies faster.
- **Better Heat-Humidity Balance!** Step-Matic Control dehumidifies without overcooling.
- **Lowest Maintenance Costs!** Completely Hermetically Sealed Refrigerating System is trouble-proof.
- **Lowest Operating Costs!** Capillary tube refrigerant feed, plus step-starting relay, reduces starting current needs.
- **Lower Installation Costs!** Adaptable to any heating system.
- **Lower Cleaning Costs!** 2 heavy filters comb dirt, dust, soot, pollen from air.
- **Quieter Operation!** Built-in compressor mufflers, cushion mountings and acoustically treated cabinet reduce operating sound to a minimum.
- **York's Five Year Protection Plan!** Your assurance of trouble-proof performance.

Now you can easily solve the problems of "hot-weather planning."

York Residential Air Conditioning—for conditioning entire homes with compact, central installations—can be your answer to heat, humidity, ventilation, circulation, dirt, dust and pollen.

There are seven York Residential Air Conditioners—for every size and type of residence. And for every kind of installation—attic, service closet, garage, basement—giving you complete freedom of design. With York you exercise freedom, too, in your choice of heating plant—because York can be adapted to any type, whether it be a forced warm air system, a gas-fired steam system, or a coal-steam or an oil-fired hot water system.

For full information on the versatile York Residential Air Conditioner . . . and how much easier it makes your task . . . call your York Representative (he's listed in the Classified Directory). Or write to York Corporation, York, Pennsylvania.

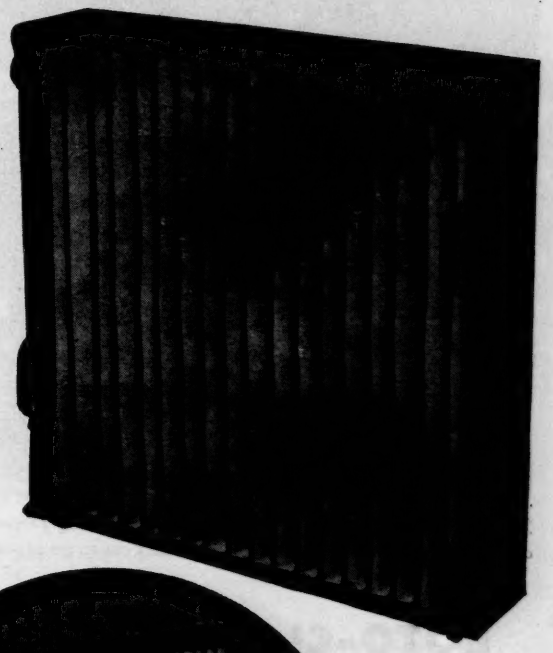
York refrigeration air conditioning

The big advances come from YORK

Headquarters for—**Refrigeration and Air Conditioning**

THERE'S A STAYNEW VENTILATION PANEL FILTER

FOR EVERY TYPE OF COMMERCIAL AND INDUSTRIAL SERVICE



Ventilation and air conditioning engineers recognize the Model WKE dry-panel filter as the most efficient unit of its kind on the market today. Wide range of media is available — it operates at maximum efficiency with any medium that comes in sheet form and can be crimped. Because of its extreme versatility, the Staynew WKE filter may be used for hundreds of varied applications.

- Greater filtering area, size for size, than competitive panels.
- Construction permits wide selection of filtering media.
- Wire screen cloth front and back of medium eliminates "sagging" and protects it so that even the most fragile materials can be cleaned over and over again.
- Can be cleaned quicker than any other type panel.
- Can be washed or dry cleaned when necessary.
- Medium can be replaced quicker than in any other panel.

Inexpensive disposable media can be furnished, if desired.

MODEL WKE Dry Panel Filter Available in 2", 4", and 8" Deep Units

One exclusive advantage with the Staynew WKE is that it can be easily vacuum-cleaned in place. Saves time—reduces maintenance costs.

For complete information write today for Bulletin DPF-100.

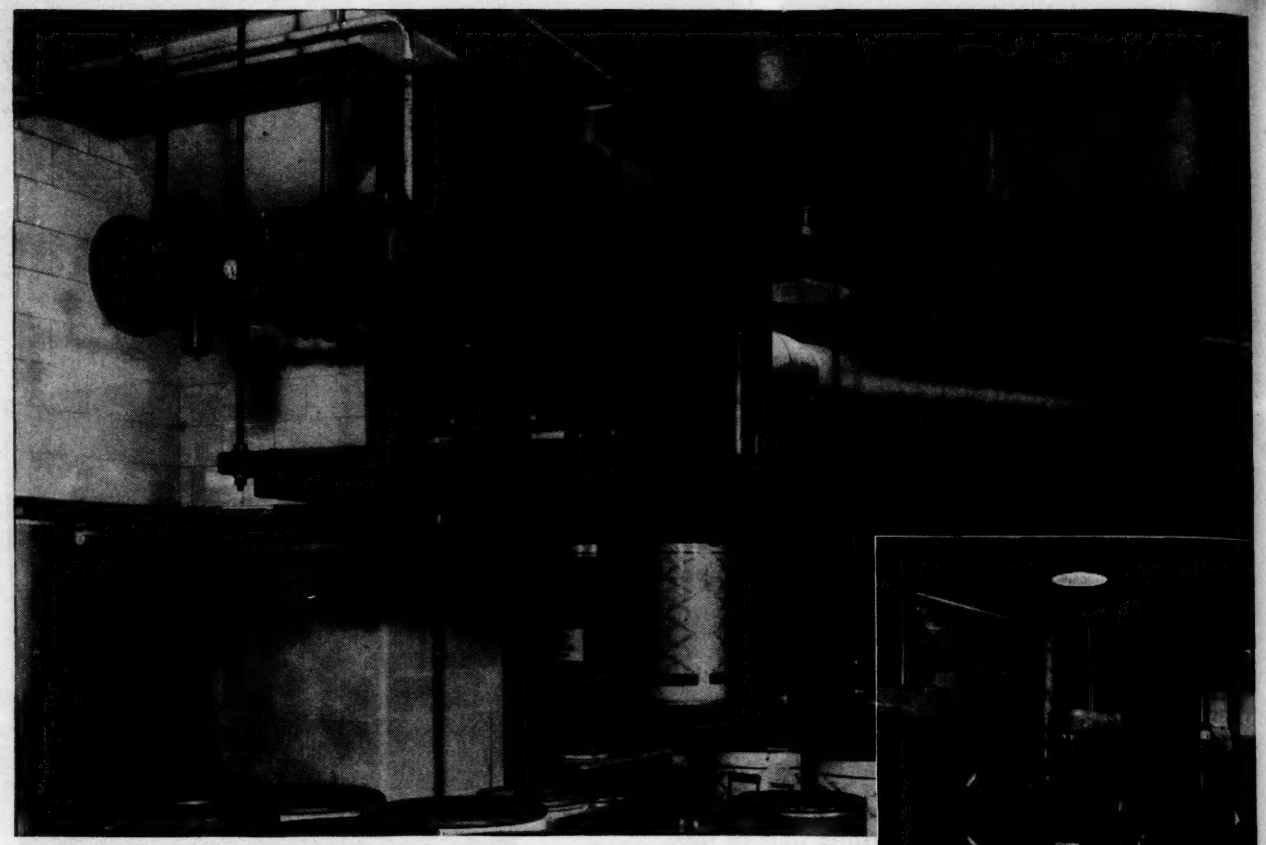
Representatives in Principal Cities

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

15 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



Type W ROTO-CLONE Arrangement A—Exhausting processing kettles on other side of end wall. Overhead mounting conserves space.

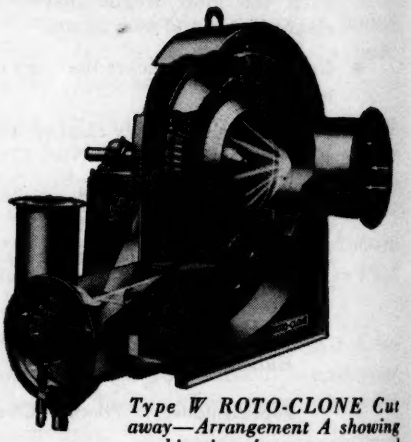
ROTO-CLONE solves fume problem for food processor

Fumes . . . from volatile ingredients are frequently a nuisance in high temperature food processing, as they are in chemical processes. AAF ROTO-CLONES, however, have solved many fume problems for both industries.

The Type W ROTO-CLONE shown above eliminates concentrated vinegar fumes from an exhaust system serving processing kettles of a nationally known food company. It eliminates the fumes so completely, that there is no indication of odors within the air conditioned spaces of the plant, despite the close proximity of the exhaust system discharge to the air conditioning fresh air intake.

This No. 12 Type W ROTO-CLONE Arrangement A has an air volume of 3,000 cfm. It's space saving installation is typical of the many types and sizes of ROTO-CLONES that are widely used to meet air cleaning problems in the chemical industry.

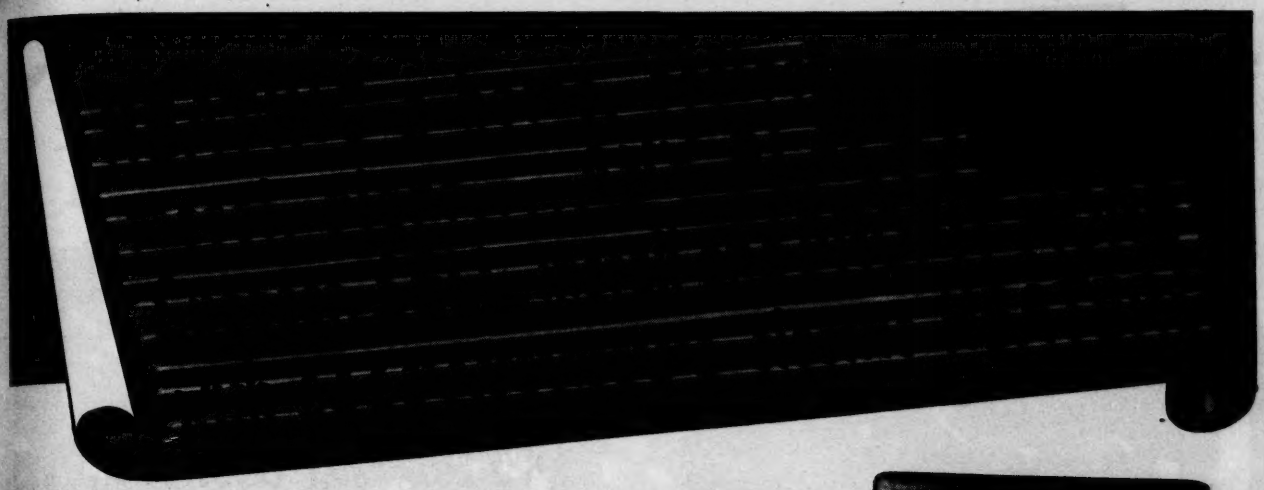
When you need *clean air* call your nearby AAF representative or write direct to us.



Type W ROTO-CLONE Cut away—Arrangement A showing combination of water sprays and dynamic precipitation.

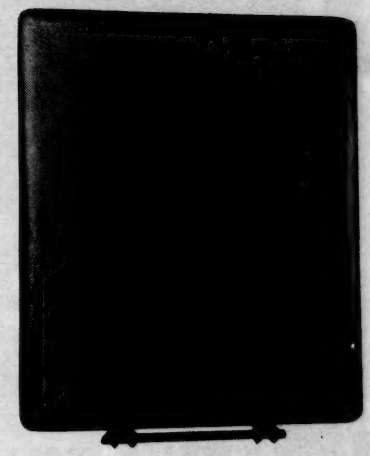
American Air Filter
COMPANY, INC.

294 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q. • Pacific Division Office, San Francisco, California

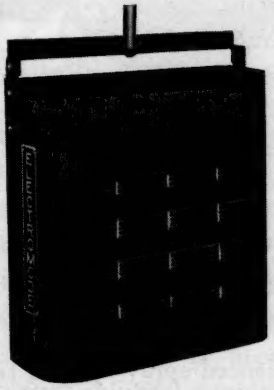


For HOMES, OFFICES, MOTELS, STORES

. . . old or new specify, sell and install Electromode Electric Automatic Wall Heaters. Here's why you'll profit . . . because Electromode offers Economy-Convenience-Comfort and Safety . . . these are outstanding features of the modern Electromode Automatic Wall Heaters. *Economical* . . . because electric heating is low-cost heating. *Convenient* . . . because each heater has its own thermostat for individual room temperature control. *Comfortable* . . . because it takes only seconds for heat to circulate by the exclusive "Down-Flo" principle . . . at floor level. *Safe* . . . because only Electromode has the long-life, cast-aluminum heating element. There is *no* danger of fire, shock or burn. Yes, these and many other PLUS FEATURES are to be enjoyed with Electromode Heaters.



AUTOMATIC DOWN-FLO MODEL WA 1500 TO 4000 WATTS

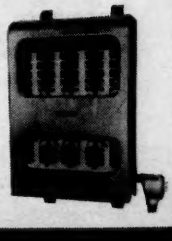


For PLANT, OFFICE, WAREHOUSE

For any plant or office heating problem, any hard-to-heat area, choose Electromode Unit Space Heaters. These all electric heaters are available in all sizes and capacities from 1500 to 45,000 watts to fit any heating problem. They can be located anywhere that electric wiring can be strung. Equipped with automatic temperature controls and built-in safety switch, means economy of operation and absolute safety from fire, shock or burn. The exclusive patented cast-aluminum heating elements will not rust or corrode. Electromodes provide an abundance of fan-circulated heat when and where it is needed. Approved by Underwriters' Laboratories and thousands of commercial and industrial plants throughout the country.

For HAZARDOUS AREAS EXPLOSION-PROOF HEATERS

The only Electric Explosion-Proof Heater of its kind approved by Underwriters' Laboratories. Features Electromode patented cast-aluminum heating element. Specially designed for installation in hazardous areas where heat is required and danger of explosion exists. Available in 2000, 4000, 6000 watt capacities.



FREE CATALOGS

. . . on Domestic, Commercial and Industrial Electric Heating, full of specifications, illustrations, installations, diagrams, and how to figure electric space heating. Send NOW—All New.

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ADDRESS_____

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ELECTROMODE
All-Electric HEATERS

Best buy for lasting economy...

MARLEY SERIES 100 NATURAL DRAFT COOLING TOWERS

Available for Immediate Delivery From Stocks In 24 Cities

CALL YOUR LOCAL MARLEY SALES OFFICE

Here is water cooling at absolute minimum cost! The years of trouble-free service built into all Marley Natural Draft Towers and their low first cost assure it.

They are strongly constructed of only heart quality redwood, the wood that withstands water. Louvers are slip fit into routed posts to prevent warping and permit inspection, and are sized and positioned to minimize drift loss.

The Series 100 balanced spray system, fitted with patented Marley non-clog nozzles, is the finest adaptation of basic natural draft design. This spray system means positive performance with little time or effort spent for maintenance.

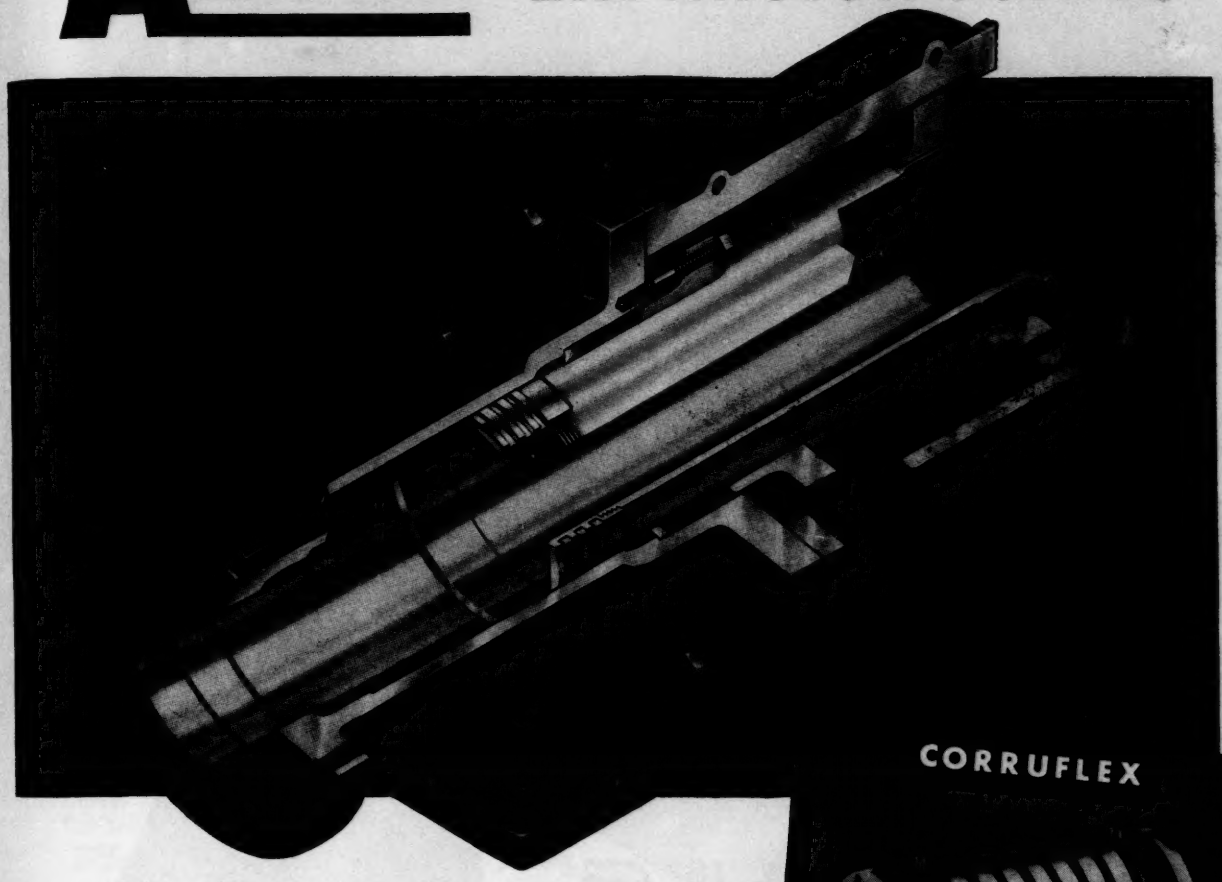
All parts of these towers are prefabricated at Marley factories for simplest construction by any available labor.

MARLEY

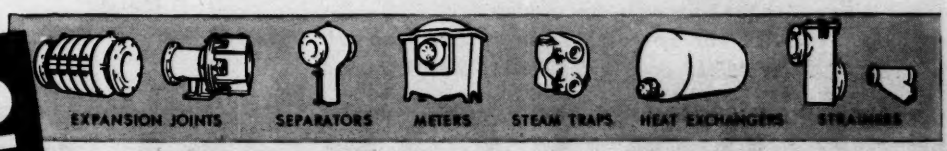
The Marley Company, Inc.

Kansas City 5, Missouri

ADSCO EXPANSION JOINTS



ADSCO'S piston-ring expansion joints can be serviced *and* packed under full-line pressure. That's why they're best. Simple and compact, they will absorb expansion caused by temperature differential in pipes carrying liquids, gases, or steam. The high-polish surfaces of these joints can never be scored, because the slips are in contact only with packing. Misalignment is prevented by both internal and external guiding. Write for Bulletin 35-15G. Remember, only ADSCO makes all types of expansion joints. We don't have to sell what you don't want to buy.



ADSCO
75 YEARS OF LEADERSHIP

AMERICAN DISTRICT STEAM COMPANY, INC.
NORTH TONAWANDA, NEW YORK

WeldELLS®

...have set their own standards

Many of the largest users of Welding fittings refuse to accept any other fittings than WeldELLS.

They have found that when the name, WeldELL, is stamped into a fitting, that fitting can be accepted without question for any service for which it is designed.

They have found that WeldELLS have features that please both the men who design and the men who erect welded piping . . . features that were pioneered by Taylor Forge . . . features that are combined in no other welding fittings.

They have found the answer to their every need in the greater range of sizes, weights and types of the WeldELL line . . . in the broader scope of materials.

Ask for up-to-the-minute facts about WeldELLS and Taylor Forged Steel Flanges.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.
Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

COMPARE..

Modine UNIT HEATERS HAVE EVERYTHING!

For heating at its best — have your representative show you a Modine Unit Heater installation. You'll notice the uniform comfort that's instantly available where and when it's needed. That's because discharge air temperature, volume and velocity are scientifically balanced.

Check fuel and power costs . . . installation and maintenance expense. Without question, you'll find all are far lower than with other heating methods.

See for yourself. *Compare* . . . and you'll choose Modine. Modine Mfg. Co., 1511 DeKoven Ave., Racine, Wis.

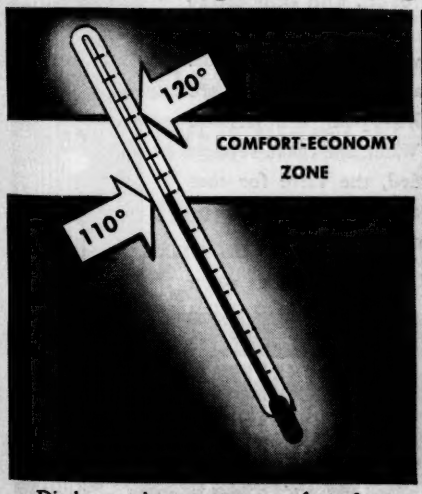
Modine UNIT HEATERS

Write for Bulletin 149-A, "Modine Unit Heating." Or contact your Modine representative listed in the classified section of your phone book.

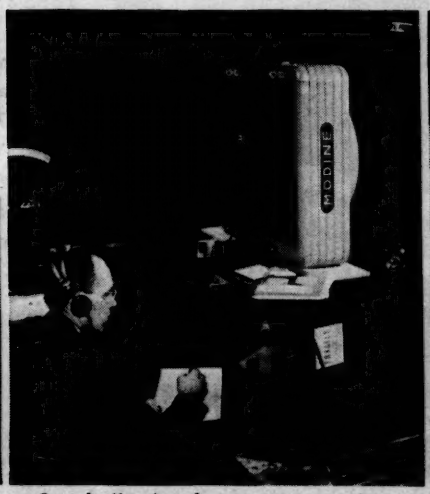
U-1118A

Vertical Delivery model shown here (available from 155 to 2550 EDR). Horizontal and Power-Throw types are also built for hot water and steam, as well as Gas-Fired units.

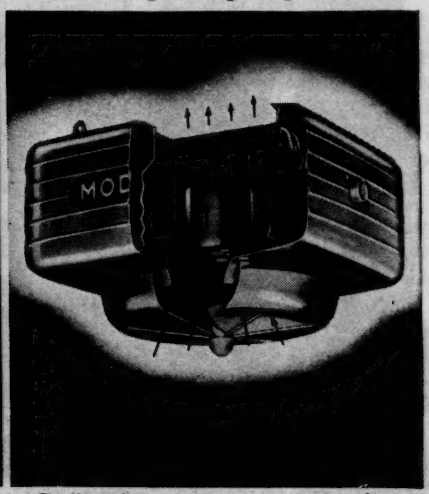
Three of many outstanding features that account for the Modine quality reputation



Discharge air temperatures of 110° to 120° F. are correctly related to air-velocities — assure perfect heating comfort plus lower fuel costs.



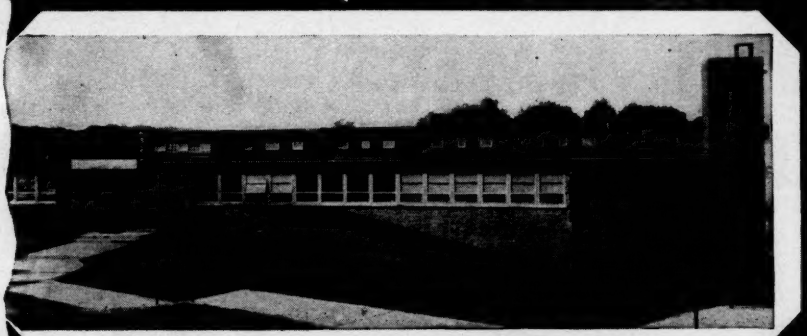
Sound-silencing features assure quieter operation—certified by accurate laboratory sound ratings. Especially important for commercial and institutional use.



Cooling sleeve protects motor when fan is not operating — safeguards against condenser radiant heat. A frequent cause of failure on ordinary heaters.

1952 TEMPERATURE CONTROL ALBUM

the place



who was there

Architect:
Ronald S. Senseman
Washington, D. C.

Engineer:
A. Dee Counts
Washington, D. C.

Heating Contractor:
E. J. Febrey & Co.
Washington, D. C.

what we did

notes of interest

A central hot water converter is controlled by a Barber-Colman CYDK Dual Bulb Microtherm*, 1 to 1 ratio, controlling a steam valve. The radiant heating system is divided into three zones—two zones of three classrooms each, and one office section zone. Each classroom has a valve and thermostat. When all rooms in a zone are satisfied, the pump for that zone stops. When the office section is satisfied, the valve for that zone closes and, in turn, stops the pump.

*Reg. U.S. Pat. Off.

BARBER-COLMAN COMPANY
1224 ROCK STREET • ROCKFORD, ILLINOIS

BARBER COLMAN

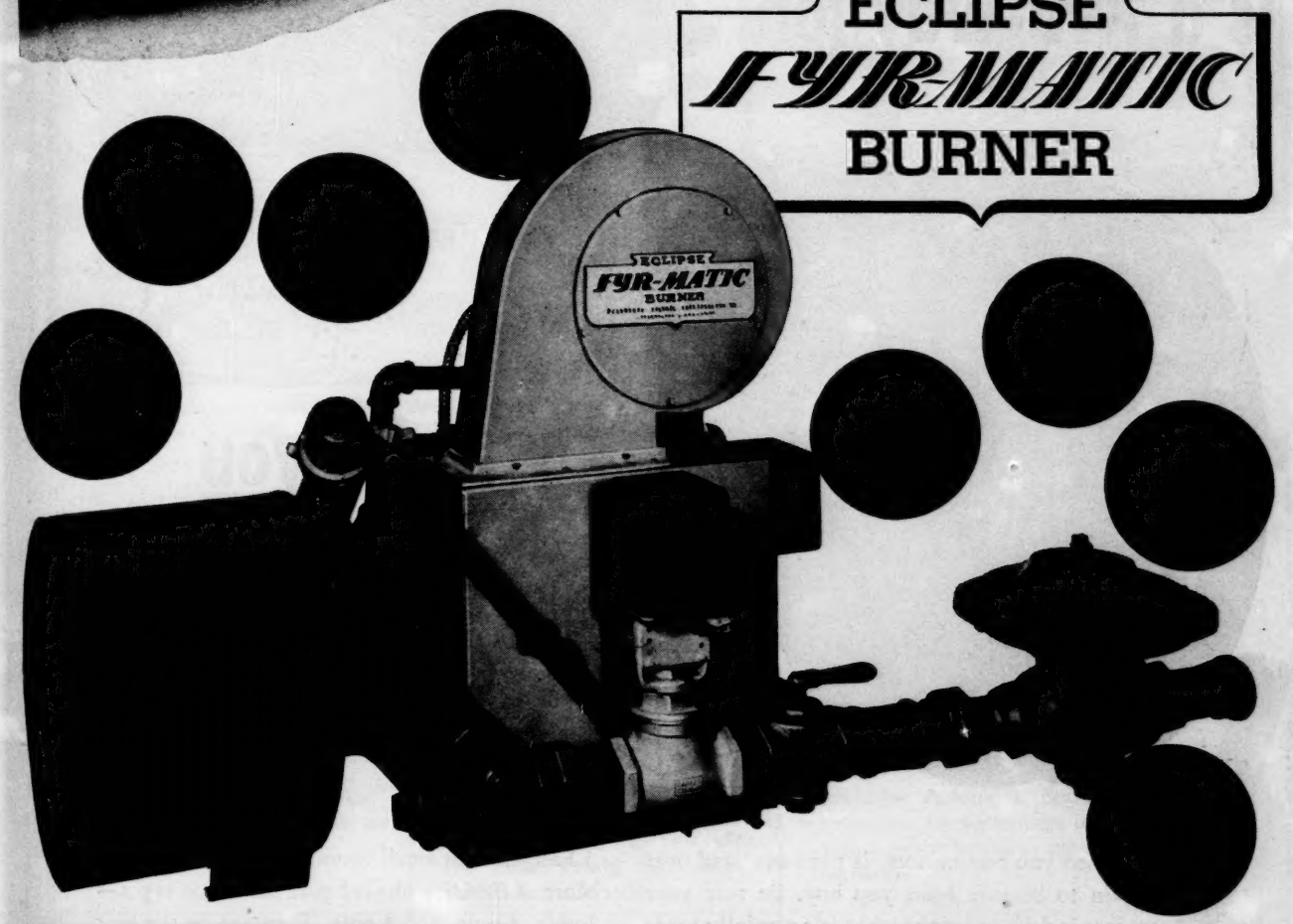
EXCITING BURNER NEWS!

Change to gas...or oil...with the flick of a switch...

use whichever fuel is m
able — o
suit

ANNOUNCING...

ECLIPSE FYR-MATIC BURNER



NEW INSTANTANEOUS CHANGE-OVER BURNER!

first to have all these features and advantages

New fuel flexibility; new dual-fuel combustion efficiency; new safety; new savings in installation and operation — for steam boilers, water heaters, air heaters, heating plants, industrial ovens, etc. Backed by Eclipse 43 years' experience building all kinds of industrial heating equipment.

Now you can use oil or gas in the *same* industrial or commercial heating equipment; change instantly from one fuel to the other with the flick of a switch — use whichever fuel is most easily available — or most economical — or most suitable at the moment... all without any mechanical or electrical changes. Eclipse Fyr-Matic's dual atomization principle enables you to burn either oil or gas with maximum efficiency. Choose from mixed, natural or LP gas (800 to 3200 BTU) and No. 1, 2 or 3 fuel oil.

Instantaneous electronic flame failure control assures positive safety of burner operation. Positive ignition in main burner; burning oil, direct electric spark ignition is used; for gas, ignition is provided by a gas pilot.

Burner is a self-contained "complete package". No "extras". Quick, easy installation. Capacity ranges 400,000 to 1,500,000 BTU. Also available as straight oil burner, for use where oil only is available.

HEATING CONTRACTORS
Ask For
Eclipse Money-Making
Proposition For You

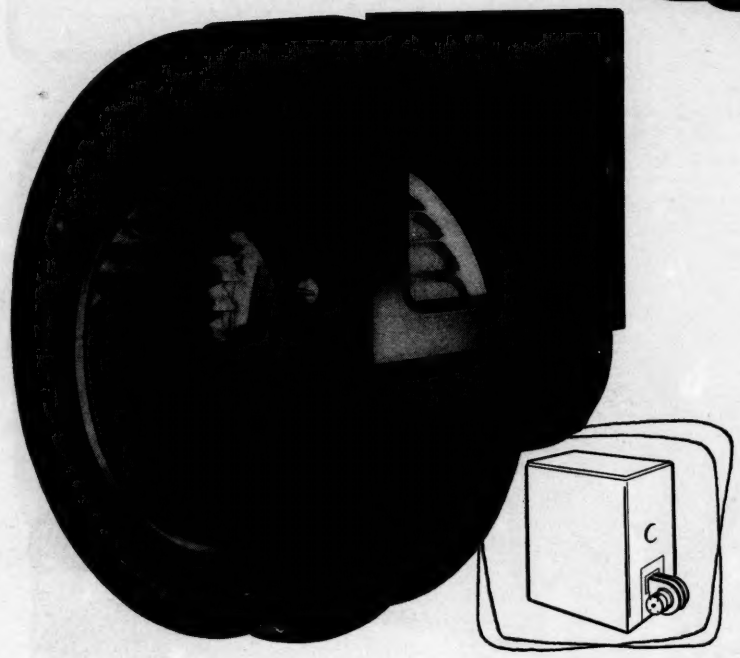
R-5908R

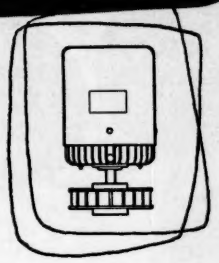
Write for Descriptive Bulletin

REPRESENTATIVES IN ALL PRINCIPAL CITIES

McKee Eclipse

Applying a Motor (or a blower) is a two-way job





...for you and Fasco engineers

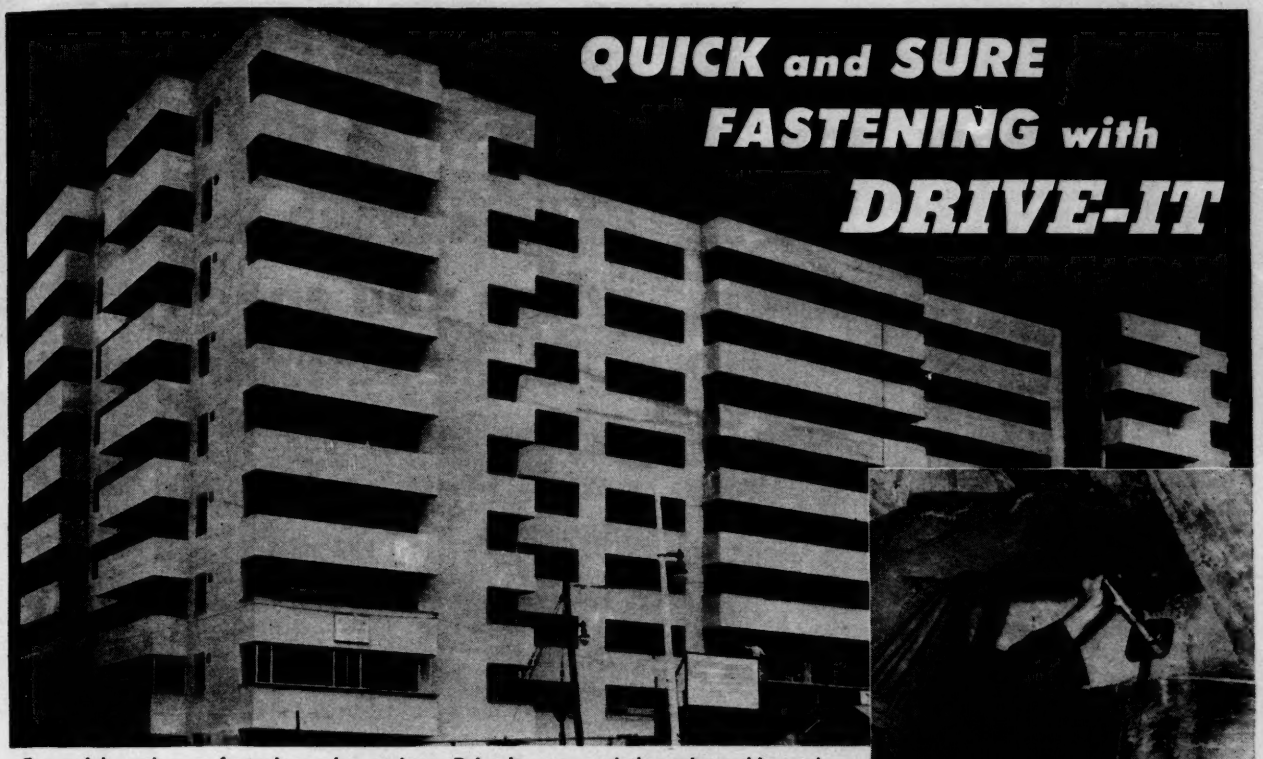
When you buy motors, it pays over and over again to be sure *before* you buy. Be sure your motor is designed right, that it's carefully made from the finest materials, that it's applied precisely and proved for *your* job. When you work with Fasco you get all this . . . and you can be sure that Fasco motors in production quantities are priced as low as possible. That's important when your product goes to a competitive market.

Fasco makes small motors (1/500 to 1/8 hp). Most of them are shaded pole induction types—2-pole, 4-pole, and 6-pole. They can be the best possible answer in numerous applications, or they can be misapplied. That's why Fasco insists that you let Fasco engineers work with you on your motor problem . . . before you buy. That way you can be sure. Fasco's engineers are ready to serve you. Just write.

For Defense Fasco also makes small auxiliary motors (6 to 48 volts D.C.) for aircraft controls, etc.—and a variety of automotive circuit breakers, pressure and signal switches, readily adaptable to defense requirements. Your inquiry is invited, and will receive prompt attention.

FASCO
INDUSTRIES, INC.
ROCHESTER 2, NEW YORK

QUICK and SURE FASTENING with DRIVE-IT



For quick and sure fastenings plus savings, Drive-It was used throughout this modern apartment house in Washington, D. C. Fastening ventilating ducts, heating units, and plumbing to concrete and steel—these and many other uses save money, time and effort.

split-second fastening to concrete steel

Drive-It uses a small powder load to drive hardened steel pins into concrete or steel. No power lines! No drilling!

DRIVE-IT is the only powder-actuated tool approved by Underwriters' Laboratory.

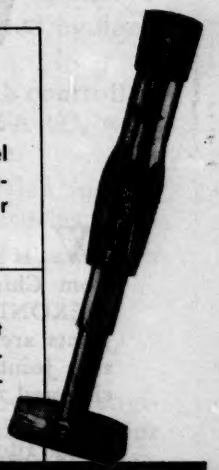
DRIVE-IT cannot be discharged accidentally due to the push and turn sequence. This, plus the large safety pad makes *DRIVE-IT* triple safe.

Exclusive Automatic Barrel Extension for fastenings inside junction boxes or other recesses.

DRIVE-IT is the only powder-actuated tool which requires but one standard power load regardless of penetration desired.

Exclusive Swivel Safety Pad easily rotated for getting into close quarter work.

Drive-It "300", lowest cost fastening tool. Low original cost and low operating cost.



MAIL THIS COUPON TODAY!

POWDER POWER TOOL CORP.
0718 S. W. Woods St., Portland 1, Oregon

☐ Please send FREE catalogue and literature.
☐ I want a FREE demonstration of *DRIVE-IT*.

Name_____

Street_____

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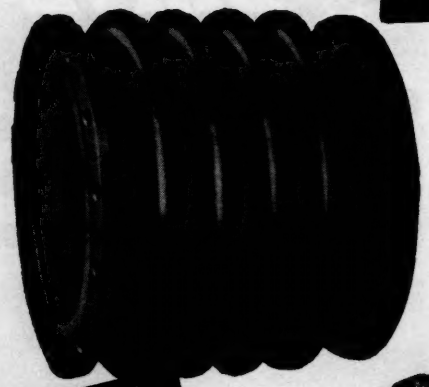
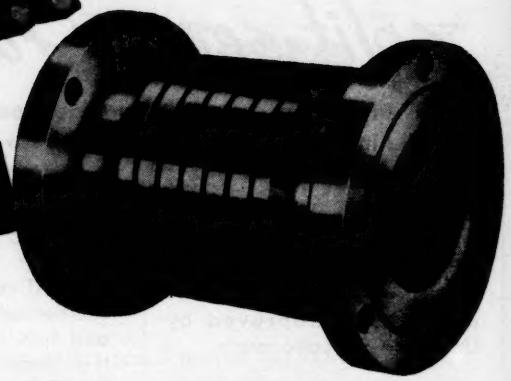
Now, say FLEXON when you specify expansion joints for piping



Free-flexing units in stainless steel or copper for pressures to 30 psi; sizes to 48" I.D.

Controlled-flexing units in stainless steel or copper for pressures to 300 psi; sizes to 48" I.D.



Integral ring units in stainless steel for pressures to 5500 psi; temperatures to 1600° F; sizes to 6" I.D.

WITH the change of our corporate name from Chicago Metal Hose Corporation to FLEXONICS Corporation, CMH Expansion Joints are now known as FLEXON Expansion Joints. Just as the corporate name was changed to better describe the company's manufacturing activities, the name FLEXON should allow easier identification of these units.

Wherever motion is encountered in piping, the problem can be solved with FLEXON Expansion Joints. These dependable units are easily installed in new or existing lines and require only slightly more space than straight pipe. They cannot leak and require no maintenance.

Write for our new Expansion Joint "Design Guide". And remember, when you specify expansion joints, you now say, "FLEXON".

Flexonics *Corporation*

EXPANSION JOINT DIVISION
1326 S. THIRD AVENUE · MAYWOOD, ILLINOIS

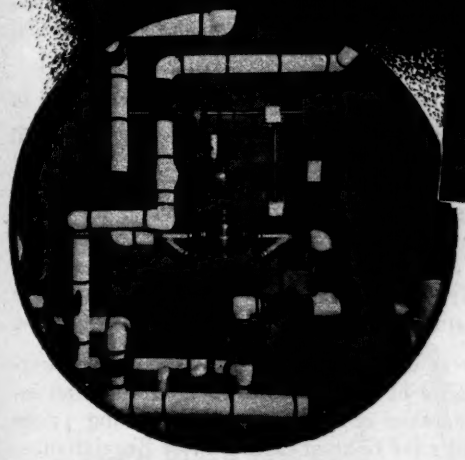
FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

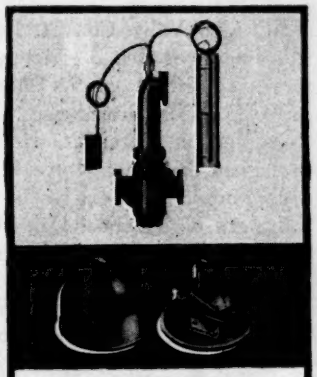
Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems • Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Sarcotherm
chosen for POTDEVIN MACHINE COMPANY'S LARGE PLANT

86,000 ft. of steel pipe are arranged in serpentine coils for the radiant heating system. Heating Contractor, Frank Lawton, Paterson, N. J



One of the 5 Sarcotherm Control valves, protected by strainers. A Sarcotherm Air Eliminator will be noted at the right.



The heart of the Sarcotherm control system is this unique control valve. It is actuated by liquid expansion thermostats, one located outside the building and one in the valve itself. Between them they anticipate changes in heat loss ratio, thus maintaining comfort temperatures under all conditions.

The Sarcotherm Comfort Control "Thermoray" is an extremely sensitive thermostat affected by both radiation and convection.

This latest addition to the industrial plants at Teterboro terminal covers an area of 102 thousand square feet.

The single story building is radiant heated by floor coils requiring 86,000 feet of pipe.

The system is divided into five zones, each controlled by a 3" Sarcotherm Control Valve, type STA-1D, with Thermoray heat-loss thermostat for each zone.

Sarcotherm also furnished Sarcoflow balancing fittings, access boxes, strainers and other accessories.

This is the largest single story industrial building in the East, radiant heated by floor coils.

We are proud that

Sarcotherm Control

was selected for this outstanding job. Individually engineered Sarcotherm Control systems are available also for conventional forced Hot Water or Steam Heating Systems. Our Engineering Department will be glad to assist on your next job.

24

Sarcotherm CONTROLS, INC.

EMPIRE STATE BUILDING · NEW YORK 1, N. Y.

A SARCO PRODUCT

BRIEFLY STATED

• Principal manufacturers of residential air conditioning equipment reported progress in organizing their trade association operations at a meeting at the Hotel Statler in New York, March 14. Formed as the Residential Air Conditioning Section of the Air Conditioning and Refrigerating Machinery Association, the group is headed by J. A. Gilbreath of Servel, Inc., Evansville, Ind., as chairman, with A. B. Newton of Acme Industries, Inc., Jackson, Mich., as vice chairman.

• A new addition to the boiler testing laboratory at the Philadelphia Naval Shipyard will make it the only facility in the U. S. and probably in the world, capable of testing full-size marine boilers. Still in the design stage, the new plant will include a 120 x 250 foot testing section where three or more boilers, including those for large carriers, may be tested simultaneously. Contract bid dates will be announced by the District Public Works Officer, Fourth Naval District. No detailed information available at present.

• Per capita use of gas in the United States has increased 287% since 1935—compared to a 176% gain in the use of electric power—it was revealed by H. L. Whitelaw of GAMA as delegates met April 2 in Minneapolis for the Mid-West Gas Association's annual meeting.

• At the Thirteenth Annual Meeting of the Propeller Fan Manufacturers' Association, officers elected for the ensuing year were E. J. Stone, president; P. T. Finch, vice-president; L. O. Monroe, secretary-treasurer. Mr. Stone is connected with Ilg Electric Ventilating Co. and Mr. Finch with the Hunter Fan & Ventilating Co., Inc.

• H. Charles Pierce, assistant sales manager of Servel's air conditioning division, has been elected chairman of the newly organized engineering committee of the residential air conditioning section of the Air Conditioning and Refrigerating Machinery Association.

• Appointment of John K. Barnes, Jr. as director of public relations of Carrier Corp., has been announced. Mr. Barnes, whose appointment was effective March 17, fills the post left vacant by the death of John F. Chester. With long experience in the field of news reporting and public relations, Mr. Barnes comes to Carrier from Lever Brothers Company, New York where for four years he was active in press, community and employee public relations activities. Prior to that he was for three years with the Ford Motor Company, Dearborn, Michigan, in general public relations activities, particularly employee and community relations.

• Barber-Colman Co., of Rockford, Illinois, will purchase the principal assets of Wheelco Instruments Co., of Chicago. Wheelco products consist of indicating, recording, and controlling industrial instruments, and combustion safeguards. Present plans are to continue current operations in Chicago until such time as manufacturing facilities can be gradually transferred to Rockford in a manner that will result in very little interruption in shipments. No changes are contemplated in Wheelco's national sales and service organization.

• Appointment of E. C. Webb to vice president in charge of production and engineering for Iron Fireman Manufacturing Company has been announced. Mr. Webb, a veteran of 22 years with the heating concern, has held the offiice of vice president in charge of research and development engineering since a year ago and prior to that was in charge of all service and field engineering in the United States and Canada.

• Stockholders of Worthington Pump and Machinery Corp., at their annual meeting re-elected their present board of directors and voted to change the company's name to Worthington Corporation.

• F. C. DeLorenzo has been appointed supervisor of the General Electric Company's Air Conditioning Division News Bureau. A graduate of the Rutgers School of Journalism, Mr. DeLorenzo has been with the G-E Air Conditioning Division since July, 1948. Prior to his new appointment he was editor of the Air Conditioning Division News, G-E external-internal weekly paper. Mr. DeLorenzo was on the staff of the Associated Press in the Newark, N. J., bureau before coming to G.E.

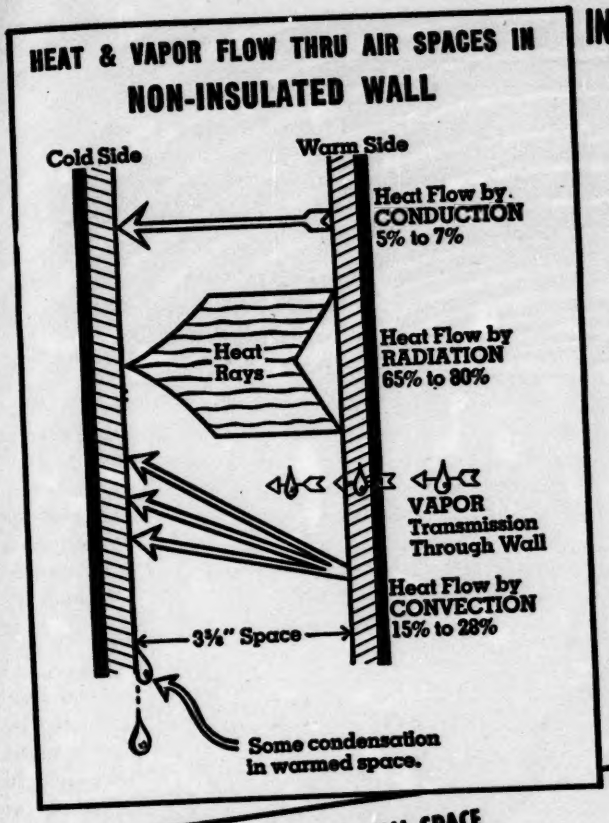
• Higher steel allotment for space heater production in the third as well as the second quarter of 1952 was forecast March 27 by the National Production Authority, Department of Commerce. Members of the new Domestic Space Heaters Industry Advisory Committee were told that the manufacturing seasonality and importance of their product are recognized in NPA's second quarter allotment of 67½% of base period—last half, 1949—use of steel. First quarter steel allotment was at 50% of base.

• Manufacturers of fiber insulating board were authorized by the Office of Price Stabilization to apply an industry-wide increase of 2.34% to their ceiling prices established under the General Ceiling Price Regulation.

• The appointment of R. Dail Moore as marketing manager of the General Electric room cooler department has been announced.

• John E. Dube, president, Alco Valve Co., St. Louis, Missouri, was elected president of the Refrigeration Equipment Manufacturers Association at its Annual Board of Directors Meeting held at The Greenbrier, White Sulphur Springs, West Virginia, on March 26. He succeeds W. A. Siegfried, president, Superior Valve & Fittings Co., Pittsburgh, Pennsylvania. L. C. McKesson, vice president in charge of sales, Ansul Chemical Co., Marinette, Wisconsin, was elected vice president. Also elected were Lud Emde, president, Temprite Products Corp., Birmingham, Michigan, treasurer; and James Emmett, Jr., vice president, James P. Marsh Corporation, Skokie, Illinois, secretary.

• Harold F. Holtz has been named sales manager of the Boiler Division for the Cleaver-Brooks Co. Mr. Holtz was former advertising and marketing manager for the company. For the past three months he has been actively engaged in sales development in the East. He is a former vice president of the Milwaukee Marketing Association and a director of the Milwaukee Industrial Advertising Association. He succeeds R. J. Tutsch who has resigned his position to form a new manufacturing agency partnership with T. P. Dyke to handle Cleaver-Brooks equipment in Wisconsin.


HEAT & VAPOR FLOW THRU AIR SPACES IN
NON-INSULATED WALL
Cold Side
Warm Side
Heat Flow by CONDUCTION 5% to 7%
Heat Rays
Heat Flow by RADIATION 65% to 80%
VAPOR Transmission Through Wall
Heat Flow by CONVECTION 15% to 28%
3¾" Space
Some condensation in warmed space.

HEAT & VAPOR FLOW THRU WALL SPACE
WITH TYPE 4 INFRA INSULATION
Cold Side
Warm Side
Negligible Conduction thru space.
Slight Conduction thru 2 spaces of Infra Insulation and 2 wall spaces.
Weight 1 oz. sq. ft.
RADIATION. 97% of heat rays reflected back by 2 aluminum surfaces: only 3% absorbed.
Of ALL heat reaching INFRA insulation, only 3% is emitted.
3%
Reduced Convection thru space.
Convection blocked by 2 impervious aluminum sheets, and fiber.
Infra's ZERO permeability forces out fortuitous vapor.
There is NO Condensation.
There is NO vapor transmission. NO absorption of moisture.

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Up-Heat	C.089, R 11.23 =	4⅗" dry rockwool
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INFRA INSULATION, INC.—525 Broadway, New York, N. Y.

INVISIBLE OPEN WINDOWS AND TRAP DOORS DRAIN HEAT IN WINTER, LET SUMMER HEAT IN

Doors and windows may be tightly shut, every chink and cranny caulked and weatherstripped, yet heat may flow out of a structure or in, right through solid walls and internal wall spaces, as if through open windows.

Obedient to nature's law, heat flows through *space* by radiation, in the form of invisible rays, from warm to cold; from warm humans, animals, furniture, walls, ceilings, floors; to colder ceilings, walls, floors, furniture, animals, and human beings. Heat also flows by conduction through *solids* when these warmer objects touch colder objects. Even the warmth in the air convected to and in contact with the wall flows into the wall by direct conduction. ("Wall" is used as a general term. The principle applies to walls, floors, ceilings and roofs.)

But preponderantly, it is radiation which wall, ceiling and floor surfaces inside a room absorb. These rays are transformed to heat which then passes through the wall by direct conduction, as does heat acquired by the wall by conduction and convection. The entire process is repeated, radiant flow preponderant, inside the wall *space* in the direction of the inner surface of the colder outer wall. The total heat which is caused by absorption of radiation mingling with the convected heat which has been absorbed by conduction, flows through the outer wall by conduction. It is finally dissipated in the colder, ambient air outside mostly by radiation but also by convection.

Heat Flow Reversed in Summer

In summer, the process is the same but the direction of heat flow is reversed; from the warm outside walls toward the colder interior walls, to be finally transferred mostly by radiation, but somewhat by convection, to the occupants of the building.

Radiation accounts for 55% to 80% of heat flow through building spaces; convection 15% to 40%; conduction 5%. Multiple accordion aluminum sheets reflect 97% of radiation, and each aluminum and fiber sheet is an effective convection block. Being mostly air, 1 oz. per sq. ft., there is almost no conduction.

Multiple accordion aluminum is non-condensation-forming. It has zero permeability to all gases—water vapor, hot and cold air, etc. No dewpoint can be reached on its surfaces or within it. It can neither sustain nor retain fortuitous moisture, for instance, rain leaking in, but expels it as a vapor because its permeability in ratio to exterior walls is infinity and the minimum requirement is 1 to 5.

Multiple accordion aluminum is available as Infra Insulation, Types 4, 6, and 4 Jr. For an amplification of this discussion, get FREE "Simplified Physics of Vapor and Thermal Insulation."

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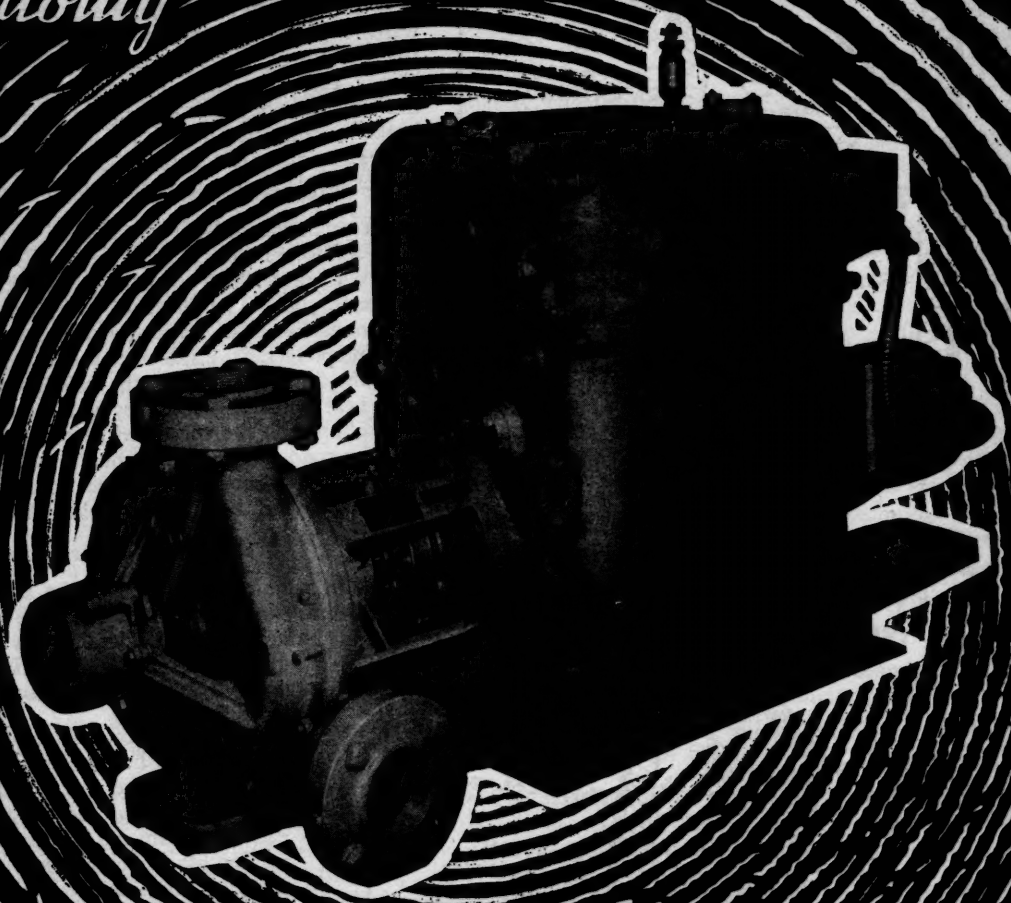
Centralized Heating Economy



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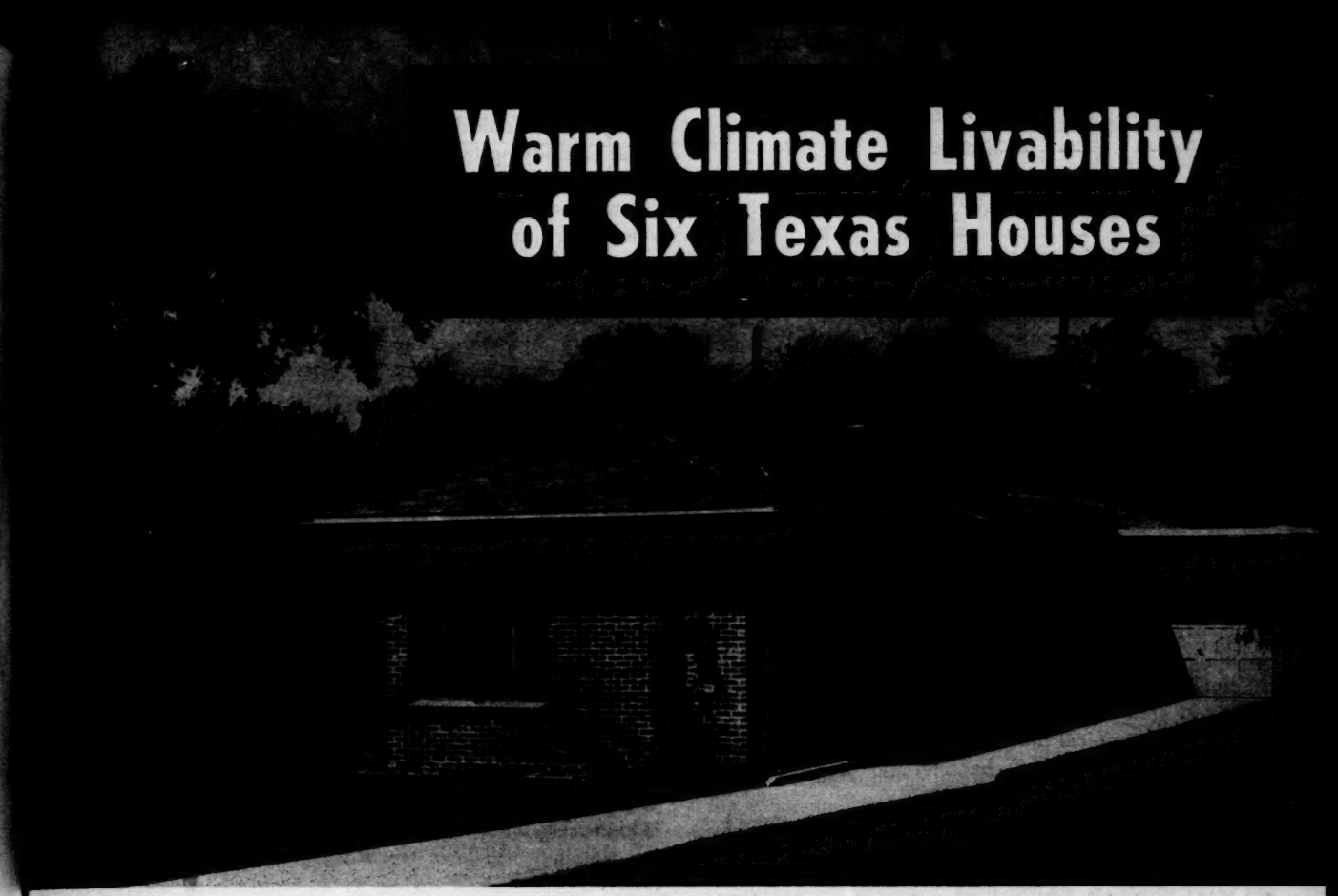
Warm Climate Livability of Six Texas Houses



W. R. WOOLRICH

The University of Texas, Austin, Texas

Design factors for increasing indoor summer comfort in tropical and subtropical houses without using mechanical refrigeration are studied in six tile and brick houses of similar orientation and floor area.

FEW are the citizens of the United States who ever take time to acquaint themselves with the tropical position of the more southerly reaches of their homeland. Austin, Baton Rouge, Mobile and Jacksonville are at latitudes similar to Alexandria and Cairo, Egypt, while Brownsville, Texas and Miami, Florida are as near to the Tropic of Cancer as Baltimore is to New York City.

Never, previous to the settlement by the white man of southern United States, have such a large number of human beings of the blonde or nordic races learned to live under as southerly conditions as prevail in the Gulf Coast and the southwestern states. The light-skinned people of these areas still have much to learn from their associated brown and black civilizations about the design and construction of livable dwellings for the hot climates. But the remarkable fact remains that for five or ten generations millions of these people with fair skins have acclimated themselves to a warm region and each succeeding generation apparently exhibits higher energy than its predecessor.

Much of the published information about the inferior capacities of individuals who are indigenous to the South can be challenged. Mostly the slower movements of the earlier settlers of the South can be traced to the ravages of tropical infections which today medical science has made nearly non-existant. The probable exception to this is to be found during the summer months in coastal areas where the combination of high humidity and temperature has a marked enervating effect which reduces the resistance of the human being to combat some forms of disease. Statistically, some indication of the improved condition of health within the southern Continental United States is evidenced by recent mortality percentage as revealed by U. S. Public Health reports which indicate that the incidence of death from heart ailments in the Gulf states is only 58% of that of New England while the cancer incidence for the Gulf area is slightly less than 58% of that for New England.

Those of us who have migrated into the South and Southwest have quite generally made an honest appraisal that many of the third and fourth generation white-skinned natives are superior in energy and mental alertness to those of us who have arrived from northern zones.

That this is not entirely a racial matter is demonstrated by the high energy of the southwestern Indian tribes of earlier periods. No student of Indian life would charge either the Apache or the Comanche with possessing low-energy characteristics, yet they spent generation as natives of the southern regions before the arrival of the white man.

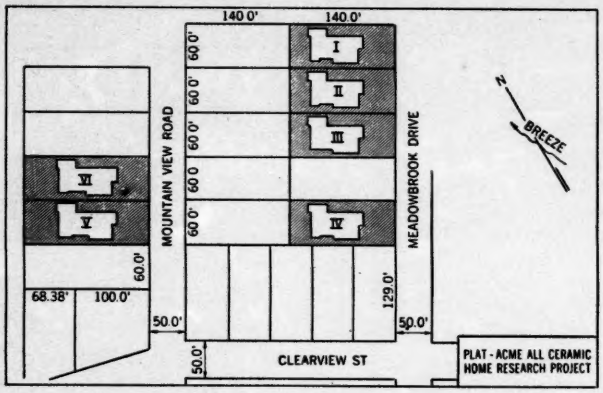


Fig. 1. Relative locations and orientation of six houses under study.

In the summer of 1946 a six home research project on tropical housing was inaugurated by the Acme Brick Co. and the University of Texas. The specific investigations selected for the project were chosen with the intent of obtaining greater livability and summer comfort in homes in a hot climate.

The test area selected has an annual minimum of four months of sub-tropical hot weather and has diurnal temperature changes that are characteristic of most semi-arid regions.

Throughout the entire summer period in Austin there is a marked uniformity in the daily cycle of dry and wet bulb temperatures—a uniformity that prevails for at least 90% of the days and nights. From one to three days of each of the summer months there probably will be storm disturbances with clouds and rain, but the remaining time is remarkably clear and the daytime sunlight is very intense.

For the typical summer days, the dry bulb will rise by 4 p.m. to between 90 and 103F while the wet bulb will remain between 73 and 77F. At night the dry bulb will fall to 76 to 78F and the wet bulb will change not over two or three degrees from the previous daytime recording. Seldom is a dew experienced in the summer although each night the relative humidity will approach saturation.

The six houses that have been under test are located with respect to each other and the meridian as shown in Fig. 1. Not only were investigations planned on the factors affecting livability of these homes but an equally important sub-tropical construction problem was included—that of studying the action of the six structures with different foundation designs when the soils changed from dry to wet then subsequently from wet to dry. The few rains and many lawn sprinklings upset the stability of the characteristic bentonitic foundation soils of the area especially after sustained drouth.

While the rainfall at Austin, Texas and London, England are quite comparable, the one area is classified as semi-arid and the other as wet, respectively, due primarily to the differences in evaporation rates. The summer time evaporation in Austin is three or four times that in London for the same period. The drying and wetting of the bentonitic and similar clays causes marked contraction and expansion with resultant foundation soil movements.

For the discussion herein, we will confine our report to the climatic livability factors and the report on the foundation studies will be referred to the journals covering construction. It is of interest, however, that this high rate of evaporation which causes foundation movements, also, may cause a localized temperature reduction in that the solar temperatures greatly affect the transpiration of shrubs, grasses, vines and trees. Where there is an abundance of verdant forms of plant life, immense quantities of water are discharged to the air with an evaporation cooling effect. The extent of this cooling by transpiration is in the schedule to be studied and measured in 1952 when the plantings will have reached a greater degree of maturity.

The six houses of similar floor surface and orientation differ from each other in arrangement of shrub and vine plantings, in methods of heating, cooling, and ventilating and in the construction of the foundations, floors, walls, windows, ceilings and roofs.

House No. I is built of timber throughout to conform fully with FHA standards. It has a double floor on joists, walls with 4-inch studding covered on the outside with 1-inch painted sheathing and on the inside with 1-inch sheathing, canvas*, and paper. The ceiling is treated the same as the walls, then has been covered with 4-inches of blown insulation. The hipped roof has wood shingles over 2x8-inch wood rafters.

*Canvas is a local term of the wall paperers. It is in reality a heavy cheese cloth used to carry the wall-paper over the board walls.

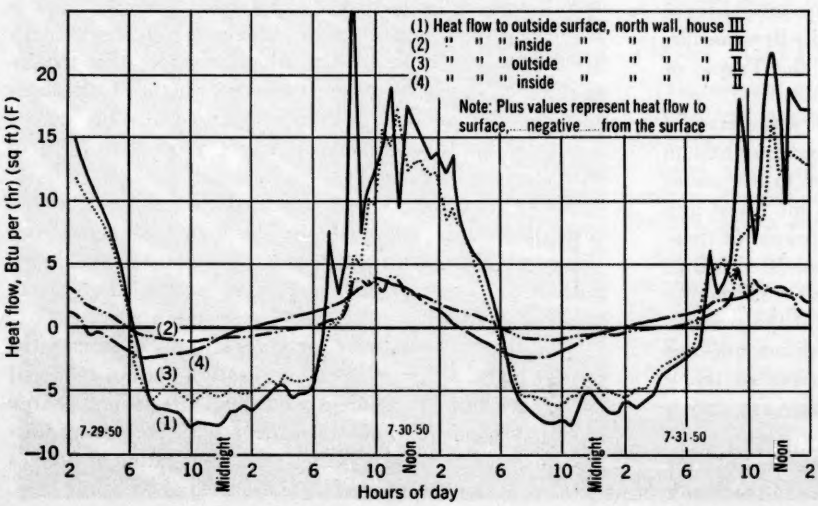


Fig. 2. A comparison of the heat flows for the north walls of houses II and III. For house 2, U = 0.4175; for house 3, U = 0.277.

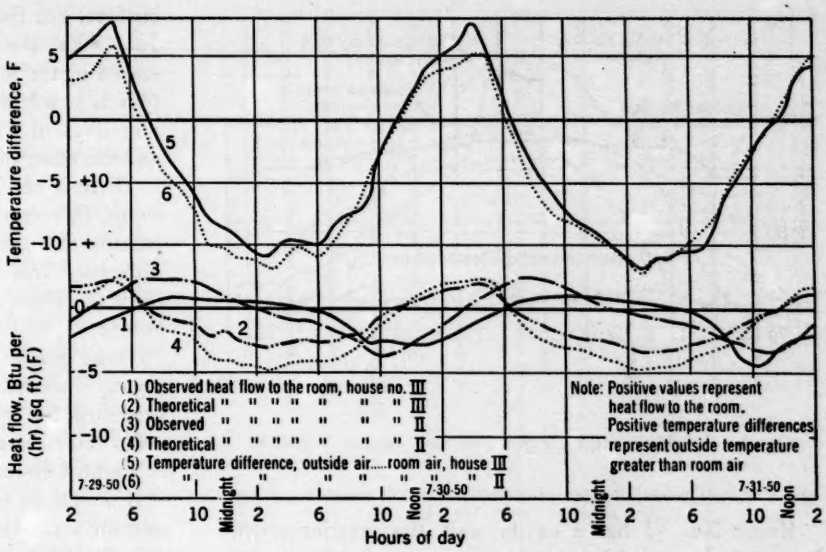

Temperature difference, F
Heat flow, Btu per (hr) (sq ft) (F)
(1) Observed heat flow to the room, house no. III
(2) Theoretical " " " " " " III
(3) Observed " " " " " " II
(4) Theoretical " " " " " " II
(5) Temperature difference, outside air.....room air, house III
(6) " " " " " " II
Note: Positive values represent heat flow to the room. Positive temperature differences represent outside temperature greater than room air
7-29-50
7-30-50
7-31-50
Midnight
Noon
Hours of day

Fig. 3. A comparison of actual and theoretical heat flow through the north walls of houses 2 and 3.

Houses II, III, IV, V, and VI have foundations built of hollow tile placed with the cells perpendicular to the wall to permit the earth on expansion to move into the cells instead of pressing against the foundation. All five ceramic houses have joistile floors, covered with concrete slabs then treated variously with wood flooring, wood blocks, or floor tile.

House No. II has 6-inch structural tile walls plastered on the inside. The tile cells are vertical. The floor is equipped with a floor-panel radiant heating system. The roof and ceiling are formed by sloping joistile slabs of two different pitches. These are covered with vermiculite insulation then over this is built up tarred felt roofing covered with stone and tile chips. The design of the roof and the orientation of the windows are planned to take advantage of the prevailing southeast breeze but in addition a large attic fan is installed to insure ample air movement and night air change.

House No. III is constructed with 10-inch cavity type walls of dense brick and tile, the outside being a wythe of brick and the interior of tile. The walls and ceiling are plastered. The roof is formed of sloping joistile then covered with tarred felt and tile chips. The building is equipped with two attic fans, one is used to draw air out of the rooms and the other to draw air from the crawl space under the floor through the floor tile and the wall cavity into the attic space and out. The crawl space is cooled by a spray of water.

The heating is supplied by dual systems of ceiling panel radiant heat and individual floor gas furnaces for each room. The radiant panel system is made up of electric sheets attached by glue to the ceiling slab then plastered.

House No. IV (illustrated in the headpiece of this article) has 10-inch cavity walls but the exterior wythe is of soft brick and the interior of soft tile. The ceiling is a horizontal joistile slab. Both walls and ceilings are plastered inside. The roof is hipped timber construction covered with asbestos asphalt shingles and supported by the joistile slab ceiling. It is equipped with a forced warm-air heating system for winter and an attic fan to afford night cooling in summer.

House No. V has 10-inch cavity walls with an outer wythe of medium hard brick and an inner wythe of medium tile. The roof is a flat joistile slab of sufficient strength to support a roof garden. This roof slab forms the ceiling of the rooms and the tile are left exposed. Likewise part of the rooms are left with exposed brick surfaces. It is equipped with two fans—one to draw warm air out of the building at night during the cooling season, the other to draw cool air from the crawl space then through the floor tile and wall cavity and then through the roof tile.

During the heating season the air is heated by a gas furnace located below the floor slab then the heated air is drawn through the wall cavity and through the roof tile thus affording both floor and ceiling radiant heating. It is possible to divert air directly into the rooms at floor level after it comes through the floor tile.

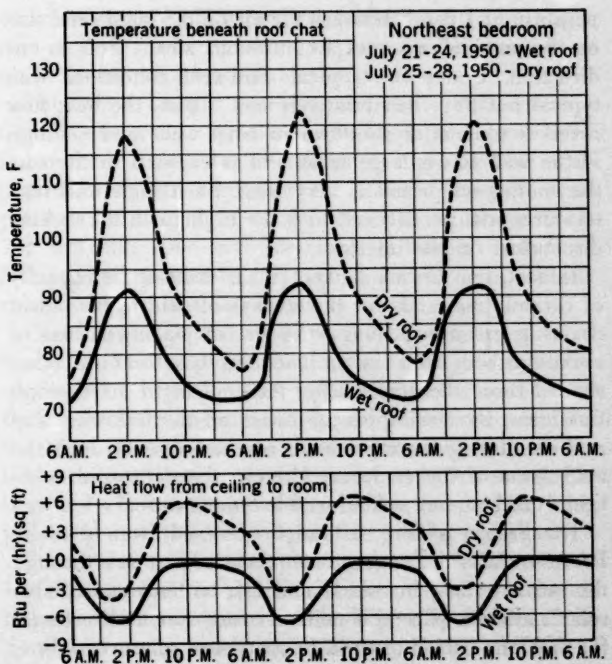

Temperature beneath roof chat
Northeast bedroom
July 21-24, 1950 - Wet roof
July 25-28, 1950 - Dry roof
Temperature, F
Dry roof
Wet roof
6 A.M. 2 P.M. 10 P.M. 6 A.M. 2 P.M. 10 P.M. 6 A.M. 2 P.M. 10 P.M. 6 A.M.
Heat flow from ceiling to room
Btu per (hr)(sq ft)

Fig. 4. Temperature studies of house No. 2 when the solar heat is intercepted by roof spray.

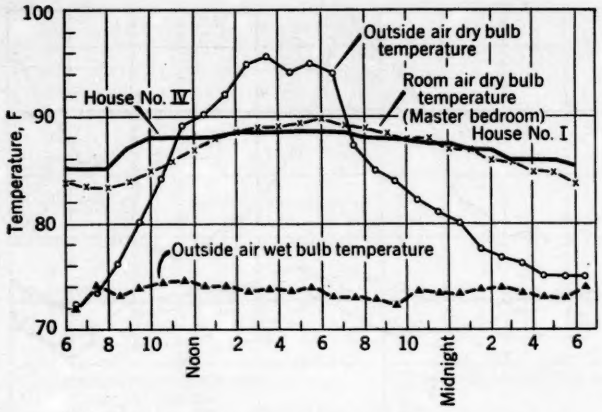


Fig. 5. Windows closed night and day, houses 1 and 4.

House No. VI has a cavity wall, the exterior wythe being of dense brick and the interior soft tile or soft brick. The roof is made up of sloping joistile slabs quite like house Number II but sloped in the opposite direction to determine the effect of the orientation of the sloping roof on the natural ventilation from the prevailing southeast breeze. This building is equipped with pipe coils placed within the roof tile through which warm water is pumped during the heating season for radiant ceiling heating and cold water is pumped during the summer so as to give as much radiant cooling effect as is possible and to intercept the solar roof heat.

Some Results of the Past Year's Investigations

Historically the U-value of heat transmission has been introduced into many building specifications of the United States whether it was justified or not. The U-value by definition as "the amount of heat in Btu transmitted in one hour per square foot of wall for a difference of temperature of 1 deg F between the air on the inside and that on the outside" assumes a continuous steady flow in one direction. Under sub-tropical semi-arid conditions with typical hot days and relatively cool nights the heat flow reverses soon after sundown in most walls and ceilings. If the wall has a large mass and is exposed to the sun, the cooling-off period is very long. Such high wall temteratures will persist well into the night with a resulting discomfort on the interior.

In fact, one German inventor has utilized the capacity of ceramic materials for the storage of cold in his patent covering a summer time procedure of placing masses of sized crushed stone in an enclosed basement or other shaded room then circulating the cool night air through this mass. By closing up the house on the following day and circulating the captive air of the house through the cold stone of the enclosure the circulated "stored cold" keeps the home at a comfortable temperature.

The graphs of Fig. 2, and 3 obtained from data by Professor Wayne Long, indicate that the heat flow through the north wall of houses II and III, without appreciable solar radiation effects, is neither steady nor undirectional for any long period of time. For a typical summer night—July 29-30, 1950 from 6 p.m. to 6 a.m.—the wall is giving up heat as is indicated by the flow recordings from each surface. For the subsequent twelve hours 6 a.m. to 6 p.m., July 30th, the heat flow is reversed and heat is being stored again in the mass of the wall. These data for this typical graph were repeated again and again for the summer days of 1950 for each of the walls tested in these and the other houses under investigation.

There is about a four hour lag for the heat flow to the room, this maximum heat movement into the room occurring at 8 p.m. while the time of maximum temperature difference was 4 p.m. The time lag of heat flow back from the room to the outside air at night is about seven hours.

These graphs indicate that the daytime comfort can be greatly increased by massive outside walls, but as was predicted for the night time, these same massive outside walls delay the cooling of the house and will be the cause of nightly discomfort.

It would be well to place this mass of material in the interior walls and carry the house loading on the interior structure then use relatively light weight walls for the exterior. If night circulation, either natural or mechanical, is used wisely, the cold of the night can be stored in the

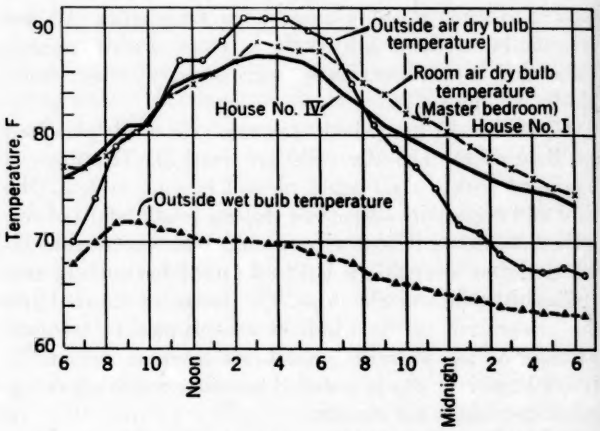


Fig. 6. Windows open night and day, houses 1 and 4.

interior construction mass and this will aid in giving a comfort condition both for day and night time.

Professor R. A. Bacon is investigating the effects of evaporative cooling of built up roofs to intercept the solar energy. The brief investigations of W. R. Woolrich and W. M. Rice on interception of solar heat by water barriers as published in HEATING AND VENTILATING in January, 1948, indicated that when the roof contour was adaptable to the water treatment it was very effective.

An example of the results of the work in progress by Professor Bacon are shown in Fig. 4. These graphs were developed from readings taken between July 21-28, 1950 on the northeast bedroom of house Number II. The upper graphs indicate the resultant temperature on the surface of roof chat on the top side of the roof when dry and when sprayed with water. The lower graph indicates the heat flow from the room under this chat when dry and when wet.

It is to be noted that the heat flow from ceiling to the room was positive or plus most of the time when the roof was dry, but that it was negative or minus for all hours of the day and night when the roof was sprayed. Of similar

interest is the lag in heat transmission under both conditions. The periods when the inside temperatures were the lowest in both cases, approximately twelve hours after the chat surface reached its maximum temperature on the outside.

Professor Bacon is preparing a complete report on his investigations for publication.

The author and Mr. Lucky Sawamura, formerly a mechanical engineering graduate student, investigated the relative effects of night air cooling with different types of walls as well as comparing the relation of natural ventilation house cooling at night with that of fan exhaust cooling. Specific comparisons were made of the FHA type frame house No. I and ceramic houses II and IV.

Curves in Fig. 5 reveal very little difference in the inside summer temperature of houses I and IV if they are kept closed day and night. There is an indication that from day to day both of these houses will accumulate more heat until they reach a thermal balance. The outside dry-bulb and wet-bulb temperatures, given on the graphs, are typical for 90% of Austin days between June fifteenth and September fifteenth.

Fig. 6 indicates that there is much to be gained by opening the windows and leaving them open at night and day with both types of houses. Ceramic house IV has a slight advantage over frame house No. 1. This is caused by the mass of ceramic material within the house accumulating more coolness at night than does the wood structure.

This same comparison between houses I and II with windows closed day and night also shows that under these conditions there is little difference in the 24-hour effect.

In a comparison between houses I and II, there is a similar relationship to that noted in Fig. 6, in the coolness gained by open windows. The ceramic mass effect in house II is again quite noticeable even when the warm outside air is permitted to circulate through the house in the daytime.

Fig. 7 indicates the effectiveness of closing windows in the morning and opening them in the evening where nights are relatively cool, as in Austin. In this particular case, for timber house No. I and ceramic house IV, fans are used. Fig. 8 shows a similar effect even when fans are not used. It is interesting that the ceramic house gave a better response than the frame building in each case.

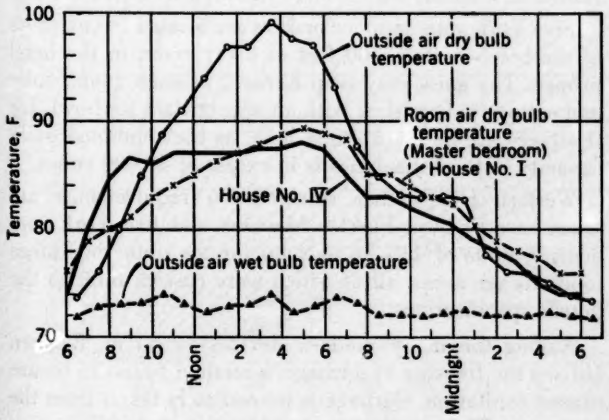


Fig. 7. Houses 1 and 4, windows closed and fans off 6:45 a.m.; windows opened and fans on 7:30 p.m.

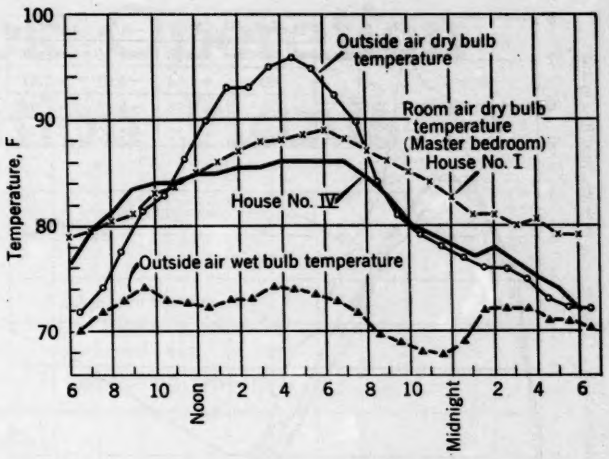


Fig. 8. Houses 1 and 4, windows closed 6:45 a.m.; windows opened 7:30 p.m.; no fans used.

A comparison of houses I and II when they are fan ventilated at night and are closed in the daytime shows similar results. The ceramic walls heat up more quickly in the morning sun because of the solar radiation, but later in the day the advantage is in favor of the brick construction. There is considerable evidence that, with nightime fan ventilation and daytime closing of the house, the optimum storage of coolness could be accomplished by using light-weight ceramic outer walls and more massive interior room partitions. Probably the early residents of southern areas, who built heavy masonry partition walls to assure room privacy, also achieved a reservoir cooling capacity by such massive wall construction.

There is also a similar effect when fans are not used for houses I and II. Again the ceramic house with its greater mass gives a better response.

Fig. 9 shows the relative effect of the four procedures on heat flow on the inside surface of the north wall of ceramic house No. II with the resultant positive and negative areas of each. Similar composite graphs have been made up for the other houses.

The temperature differences under the different conditions shown may appear small. Those who have lived in southern zones during sustained high daytime temperature periods recognize the room-discomfort temperature limit for most residents is approximately 85F at 77F wet-bulb. Any small increment of temperature above 85F is very noticeable and such discomfort has a direct relationship to this increment.

Other investigations under way deal with the effect of transpiration of adjacent shrubs, vines, and grasses on the cooling of a house in arid regions, with the methods of the earlier races and our own American settlers in obtaining relief from the summer heat in their houses, with the better utilization of natural air currents by house orientation and air current diversion baffles and by obtaining improved results from evaporative cooling installations.

It may be well to re-emphasize the desirability of taking advantage of the nightime cooling capacity of the air to make the homes more livable. The early settlers of the Southwest made much practical use of this method of keeping a house cool. In our competitive race for air conditioning by mechanical means we have overlooked

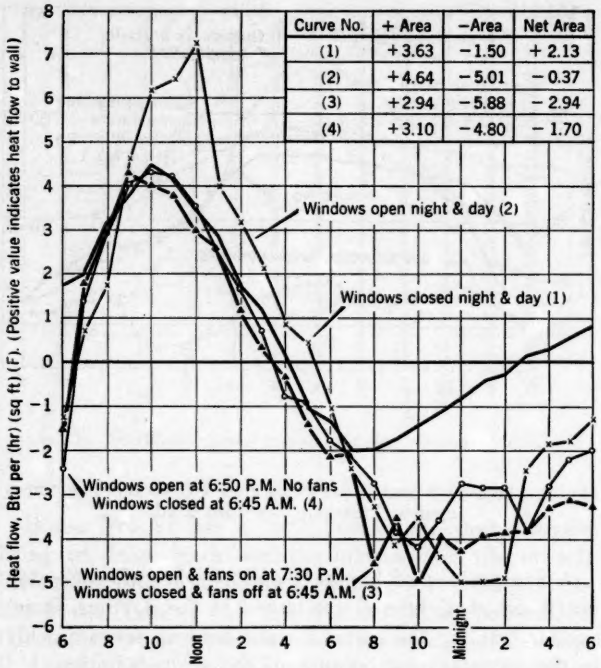

Curve No. | + Area | −Area | Net Area
(1) | +3.63 | −1.50 | + 2.13
(2) | +4.64 | −5.01 | − 0.37
(3) | +2.94 | −5.88 | − 2.94
(4) | +3.10 | −4.80 | − 1.70
Windows open night & day (2)
Windows closed night & day (1)
Windows open at 6:50 P.M. No fans
Windows closed at 6:45 A.M. (4)
Windows open & fans on at 7:30 P.M.
Windows closed & fans off at 6:45 A.M. (3)
Heat flow, Btu per (hr) (sq ft) (F). (Positive value indicates heat flow to wall)
Noon
Midnight

Fig. 9. Heat flow on inside surface of north wall in master bedroom of house No. 2.

some of the excellent features that can be incorporated in houses by taking advantage of natural ventilation. A large number of our citizens will not be able to afford mechanical methods of cooling for some years to come, but we can give them livable dwellings by employing simple yet effective measures.

Even the coastal regions possess some hope-instilling history if our geographers are correct when they tell us that the highest and most energetic civilization of the Americas, before the white man's invasions, prevailed for many centuries in the area that is now Yucatan, Honduras, and Guatemala. We who practice our professions in the semi-tropical climates should not, however, overlook our responsibilities as engineers and architects to utilize to the ultimate those factors which can raise livability and human energy to their highest attainable levels.

A house design that includes all of the proven procedures to reduce the summer daytime temperatures of even low-cost construction is most desirable. This study exhibits only a part of the design factors that should be recognized in achieving more livable structures for the semi-tropical zones of this earth.

The Building Research Advisory Board of the National Research Council has recognized that marked deficiencies exist in the knowledge and data available on the livability and economic factors affecting tropical housing and has organized an active Committee on Tropical Housing and Building within its own framework. It has authorized the naming of three sub-committees on tropical housing under the direction of the Universities of Florida, Texas, and California at Los Angeles respectively. A national conference on Tropical Housing and Building will be held in Washington, D. C. under the auspices of BRAB in the fall of 1952 with each of these three regional sub-committees cooperating.

Packaged Air Conditioning For New Hotel

Western Hills, a new luxury hotel in Fort Worth, Texas, is representative of a growing tendency toward air conditioning multi-room buildings with sealed circuit, packaged air conditioners, according to A. W. Stubbeman, president of Almar-York Company, Inc., of Forth Worth.

The 200 room, $2,000,000 hotel, located six miles from the center of the city, requires over 180 tons of air conditioning to take full care of its needs and those of the 20 cabanas and cottages on its grounds in the immediate vicinity of the main building.

Because of the architectural layout of the hotel a central air conditioning system was considered neither practicable nor economical. The main building is of two stories topped by a penthouse comprising the third floor, and is flanked by three large wings of one story each. Then there are eight cabanas (Spanish for cabin) and 12 Texas-size cottages. The basement runs under only one wing and there is a partial, smaller basement under the central building.

To meet the air conditioning problem, 46 separate York hermetic systems were chosen to fulfill the demands for 182 tons capacity. The majority of the units range from 3 to 5 hp, while a few 1½ and 2 hp package units handle smaller, remote areas. This system precluded the necessity of air conditioning whole blocks of rooms when not in use.

It was also pointed out that the use of the hermetic units permitted their installation in out-of-the-way locations such as basement areas, utility rooms and closets, saving space and considerably reducing building costs.

The hermetics were also selected because of their high degree of adaptability to heating systems to which they are easily connected, thus providing year-round air conditioning which is a growing practice throughout the Southwest.

Heating is furnished throughout Western Hills by staggered, finned-tube, heating coils mounted in the conventional manner, with boilers installed adjacent thereto.

Five York automatic ice makers are located in corridors of the hotel—within 100 feet of every room in the hotel proper. The guest may help himself, as each room, suite and cottage is furnished with an appropriate ice bowl. Ice shortages are never expected here, as the combined daily capacity of these machines is in excess of 40,000 cubes.

Western Hills' other refrigeration requirements are taken care of by a FlakIce Machine and five York condensing units of 1½ hp to 2 hp for the numerous large food storage areas, all of which were custom built to the hotel's specifications.

Among the many modern devices found at Western Hills is the freezing of garbage, a method found to insure utmost sanitation. Garbage is immediately taken from the kitchen and frozen, then removed to a special walk-in type refrigeration room where it is stored until taken from the premises.

Charts to Check Operation of Refrigeration Plants

JEROME M. MORSE

By the use of two simple charts, a plant operator can find the tons of refrigeration being produced and, under certain conditions, if the control is functioning properly. These charts were originally used to help test refrigeration units in a large research-laboratory.

THESE two graphs, Fig. 1 and 2, were prepared in the hope they may be useful to engineers operating refrigeration plants and their use may result in better plant operation. They have proven very handy when starting up and testing new installations. The charts will be found quite accurate for all practical purposes.

To use these graphs, the refrigerating plants must be equipped with a flow meter on the chilled water circuit and thermometers on the inlet and outlet water connections.

The graphs will prove useful where there are two or more compressors connected to a common chilled water

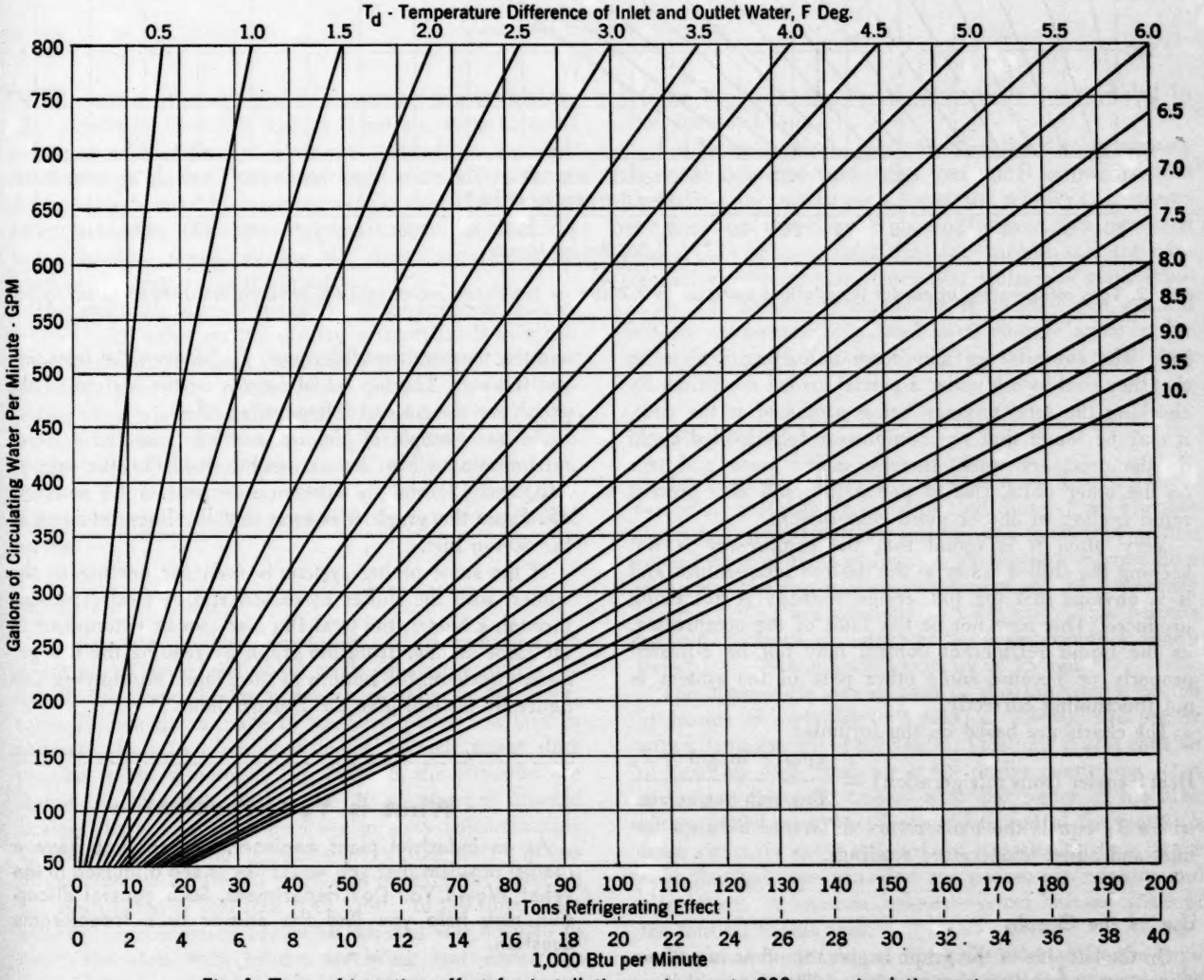


Fig. 1. Tons refrigerating effect for installations using up to 800 gpm circulating water.

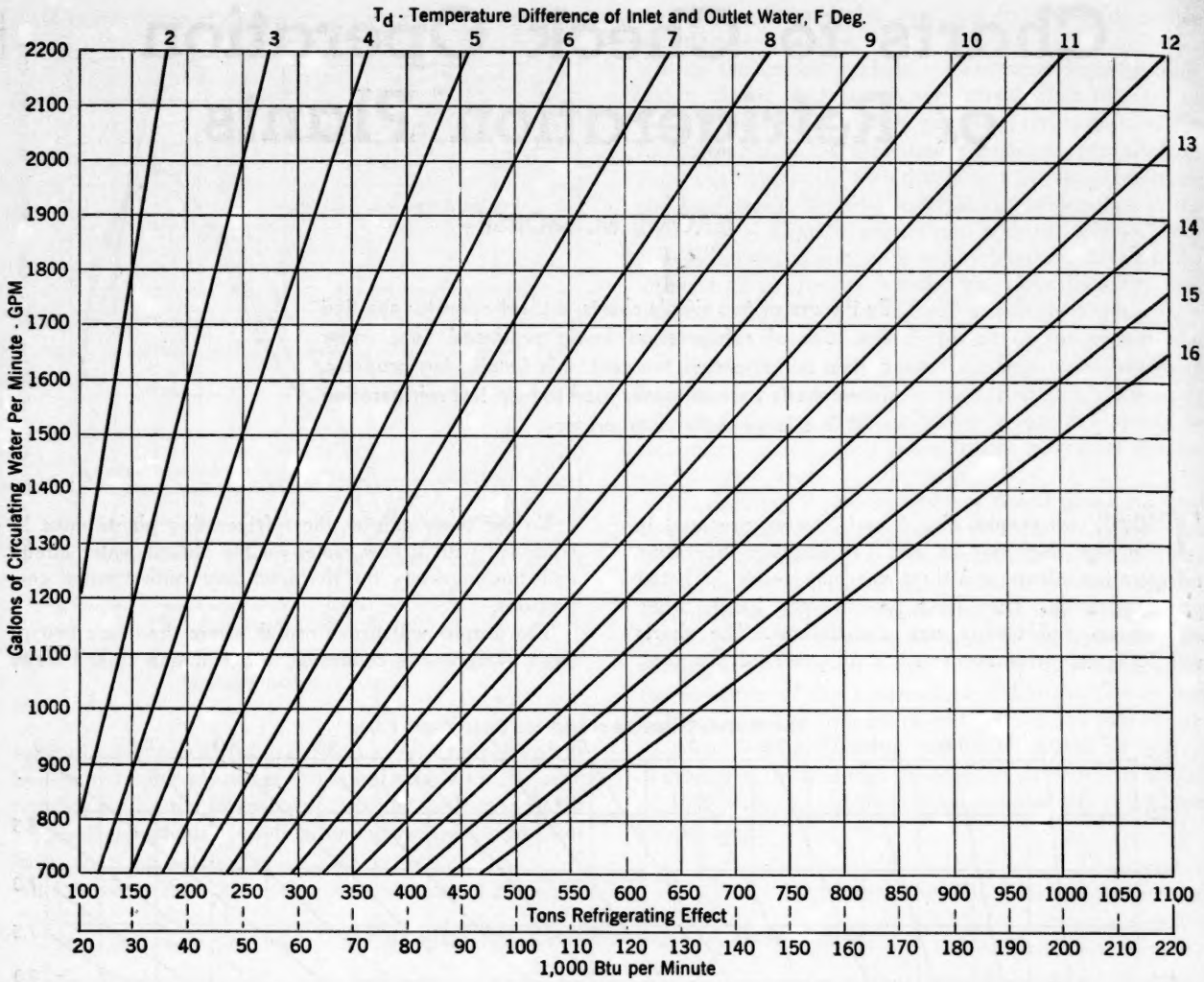


Fig. 2. Tons refrigerating effect for installations using up to 2,200 gpm circulating water and for temperature differences up to 16F

line. The compressors may have unloading devices so that they could work under a partial loaded condition. By checking the total tonnage being produced at the time, it may be found that one compressor fully loaded could do the necessary work, thereby saving wear and tear on the other units. Use of one unit would also prevent rapid cycling of one or more compressors.

Very often it is found that the compressor is not keeping the chilled water at the desired temperature and it is obvious that the full design tonnage is not being produced. This may not be the fault of the compressor, as the liquid refrigerant control may not be adjusted properly or because some other part of the system is not functioning correctly.

The charts are based on the formula:

$$\text{Heat transfer (tons refrigeration)} = \frac{\text{gpm} \times \text{lb/gal} \times T_d}{\text{Btu/min/ton refrig.}}$$

where T_d equals the temperature difference between the inlet and outlet temperature readings.

Use of the Graphs

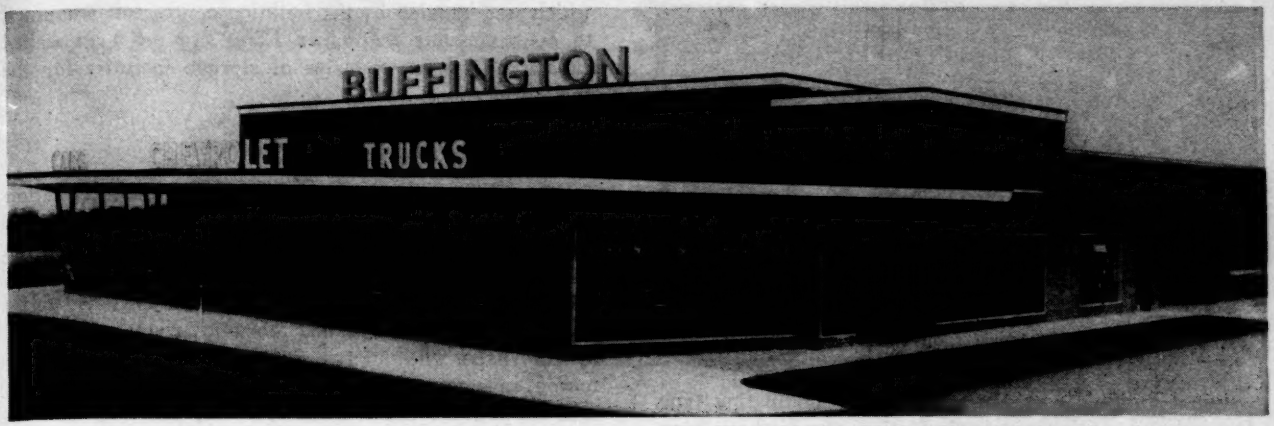
On the left side of the graph is given the flow in gallons per minute of chilled water or brine. The diagonal lines are the temperature difference, T_d, between the inlet and outlet water. The top set of figures on the bottom of the graph are the tons of refrigerating effect.

As an example of the determination of the tons of refrigerating effect, let us assume that, (1) the gpm is 240, and (2) the T_d between inlet and outlet water is 4F. From the graph it is seen that the lines intersect at the 40-ton line.

If the same piping system is used for heating in the winter, with the chiller by-passed and the water passing through a heater, the total Btu load can be determined in the same manner from the graph by reading the Btu per minute scale on the bottom of the graph. Multiplying this figure by 60 will give the Btu per hour.

What is Your Problem?

As an industrial plant engineer, perhaps you have a special problem that you would like to see discussed in the What Would You Do? department. Such general discussion may help you find the answer to a troublesome question.



Because of the large amount of window glass used, a window defrosting system is important for this showroom.

Window Defrosting System for an Automobile Showroom

WILLIAM H. REYNOLDS

Mechanical Engineer, Gary, Ind.

THE owner of an automobile showroom is maintaining relatively frost-free display windows, even at temperatures of —10F, by a simple method. A warmed mixture of outside and recirculated air is introduced from the window bottom in a wiping action over the floor-to-ceiling windows. This arrangement has produced excellent defrosting results during the recent severe winter weather encountered in this area.

The architect, in his instructions to the designer, placed a substantial value on the display of merchandise in the show windows. The large size and the nature of the merchandise, primarily automobiles, dictated the floor-to-ceiling show window design with large glass areas. There are approximately 1,400 sq ft of ¼-inch plate glass in the display area of this building, most of which extends from the floor line to the ceiling. It was imperative to keep this glass as nearly frost-free as possible by some economical means.

Installation of Ducts

A plan was finally developed for distribution of warm air at floor level at an angle of approximately 45 deg to the glass. From a plenum chamber in the floor, three 12-inch ducts made of spiralled paper and laid in concrete, lead to three sections of 12-inch paper duct parallel to the windows. The ducts at the windows are slotted and formed so that the air discharges upward against the windows at the floor in slots approximately 20 inches long by one inch wide alternating with 9 inches of unslotted area. The air discharge velocity was designed for approximately 350 fpm at the outlet of the slots. This velocity was increased somewhat when it was decided to cover the slots with bronze screening laid under the asphalt flooring tile for reasons of safety and cleanliness. Means for balancing the three sections are provided in the plenum chamber.

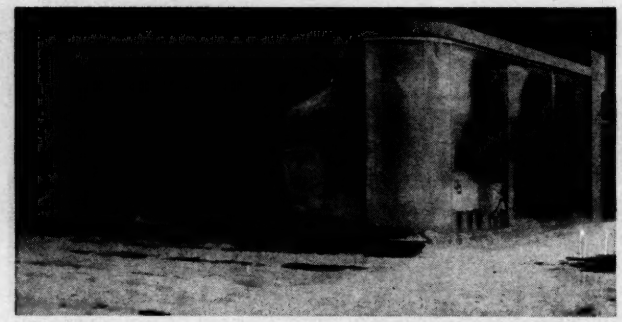
A sufficient quantity of air to offset the display window losses is delivered to the slot system. It is realized that delivering the warm air against the windows, increases the heat loss through the glass. However, this increased loss should be no greater than for conventional anti-condensation systems using radiation under the glass exposures. The balance of the air for the display area, general offices, conference room and parts storage area, is distributed through a conventional type of sheet metal duct system.

Heating System

The heating unit for this system is a direct oil-fired, forced-air unit manufactured by the Chicago Steel Furnace Co., rated at 500,000 Btu per hr, and is located on the second floor of the building. A sheet metal exhaust duct eliminates the cost and space requirements of a masonry chimney. The fan capacity is 5,500 cfm. This permits up to 41% fresh air intake at the design outdoor conditions of —10F and a wind velocity of 15 mph.

The automobile service area of this building is heated by means of a similar unit rated at 750,000 Btu per hr with a fan capacity of 8,500 cfm. This unit is also capable of handling 41% fresh air at the design conditions. It is suspended from the trusses near the center of the area with a distribution duct from end to end of the space. A fresh air intake above the roof and a recirculated air intake near the floor are provided for proper air mixture and circulation. A separate exhaust system handles some of the foul air in this area.

The control system, as originally selected by the engineer, was not used because of a desire to economize in the



Condensed moisture spoils window displays.

original building cost. In place of the modulating type burners and continuous air circulation, standard gun-type high pressure burners were installed. An outdoor thermostat is wired in series with the inside thermostat to operate the burner in accordance with outside or internal conditions. A bonnet temperature regulator operates the blower in the conventional manner. This does not provide continuous fan operation which was at first considered necessary for this installation because of the ventilation requirements in the service area and the necessity of keeping car exhaust odors out of the other building areas. This system, however, reduced the first cost by approximately $3,000, and is apparently working to the satisfaction of the owner and his employees. There are no indications of foul air in the office and showroom areas from the service area.

A small gear type pump circulates commercial grade No. 3 fuel oil to the two burners from underground storage. Although this system has not operated through a complete heating season, preliminary investigation indicates reasonably economic operation. The complete installation cost, including fuel pumping and the underfloor duct system which was handled by the building contractor, amounted to approximately $7.80 per 1,000 Btu per hr installed capacity. This is exclusive of storage facilities for the fuel oil.

Difficulties with System

Some difficulties were encountered in the installation and operation of the system which are worthy of note. The 12-inch round paper ducts were found to be quite difficult to install when the concrete surrounding the duct was delivered too wet. One section of the duct had to be replaced because it absorbed too much water and tended to lose shape. The duct of course has a strong tendency to float in soupy concrete. The use of a comparatively dry mix around the ducts eliminated this problem. Waterproofing the outside of the duct would also aid in combating this difficulty. The problem of balancing the system was not difficult but sometimes tedious as with any complex system of heating. Patience and care solved this difficulty. Although conforming to local codes, it was found that the 15 ft distance between the stack outlet and the fresh air intake was insufficient. It was found necessary to add 8 ft to the stack height to eliminate combustion gases in the air system. The prevailing wind was instrumental in aggravating this situation.

In general, this system has proved to be a very effective method of display window defrosting. This duty, combined with satisfactory heating and adequate ventilation for the entire building, makes this system one of the most efficient pieces of equipment in the building.

Acknowledgments

Architect, Fred Collins, Gary, Ind.; heating contractor, Olson Corp., East Chicago, Ind.; and general contractor, Gerometta Construction Co., Gary, Ind.

Heating Plant Serves Two Church Buildings

Solution of a dual heating problem with savings in construction costs for the new Immaculate Heart of Mary School in Rutland, Vermont, was accomplished by the installation of a new heating plant in the basement of the adjoining church. The new heating plant, replacing a steel boiler, provides essential heat requirements to the church, and in addition, services the recently completed school building with adequate, low-cost heat at even, comfortable temperatures, as well as supplying domestic hot water.

Of modern design, the new Immaculate Heart of Mary School contains nine classrooms with appropriate washroom, toilet, shower and office facilities. Included in the 285,000 cubic feet, two-story structure is an auditorium that is easily converted to a gymnasium. This provides an added use.

The new heating system meets the exacting specifications of the architects for efficient performance, and at the same time, is in keeping with the modern design of the school in function and appearance.

Included in the savings in construction costs is an equally important conservation of space. In fact it was the desirability of utilizing available space to maximum advantage that prompted architects Dirsa & Lampron of Manchester, N. H., to investigate the possibility of economically and efficiently heating church and school from the same source. Further consideration led to the selection of a commercial steel boiler made by The National Radiator Co. It was decided that this new automatic oil-fired boiler, replacing an old steel unit, would supply steam heat for the church and forced hot water for the heating system in the new school.

Space that otherwise would have been sacrificed for utility purposes as a boiler room in the school building, was incorporated in the plans to provide an extension of educational facilities.

Snow Melting System Design for a Shipping Center

JOHN E. ZIEGLER

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SNOW melting for industrial applications in the last few years has met with increasing popularity. Manufacturers are recognizing the fact that snow melting is not only feasible, but the most efficient and least costly method of removing snow. A properly designed system is automatic, works around the clock with no manpower required. It offers complete utilization of the total area without snow piles.

One example is the system built into the concrete approach to the truck loading dock at the Hansen Laboratory's new warehouse and shipping center now under construction in Herkimer, N. Y. This snow melting system, for an area 20 ft wide by 60 ft long, was designed and installed by the H. J. Brandeles Corp., Utica, N. Y. The basis of design for this system was to melt one inch of snow an hour. This is the generally accepted design figure for most snow melting installations and this requires a heat output of approximately 100 Btu per hr per sq ft of melting area.

The piping layout as shown in Fig. 1 calls for 1,300 ft of one inch Type K, soft temper copper water tube, composed of five circuits, each of a sinuous pattern having four parallel rows. From a hydraulic standpoint, each circuit is hereby limited to a maximum length of 250 ft. This circuit length is actually shorter than necessary, but was reduced in this case to keep the friction head on the circulating pump at a reasonable value and at the same time to keep the velocity below a critical range.

The copper tube was furnished in coiled 60 ft lengths. To facilitate keeping the tube straight as it was uncoiled, the contractor made a simple guide by nailing two strips of scrap lumber to a plank as shown in Fig. 2. These strips were spaced 1¼ inches apart to accommodate the copper tube of 1⅛ inches O.D.

The return bends at each end of the area consist of two 90° bends made with a portable mechanical bender, Fig. 3, to give a center to center tube spacing of 12 inches. Time of fabricating the coils could have been

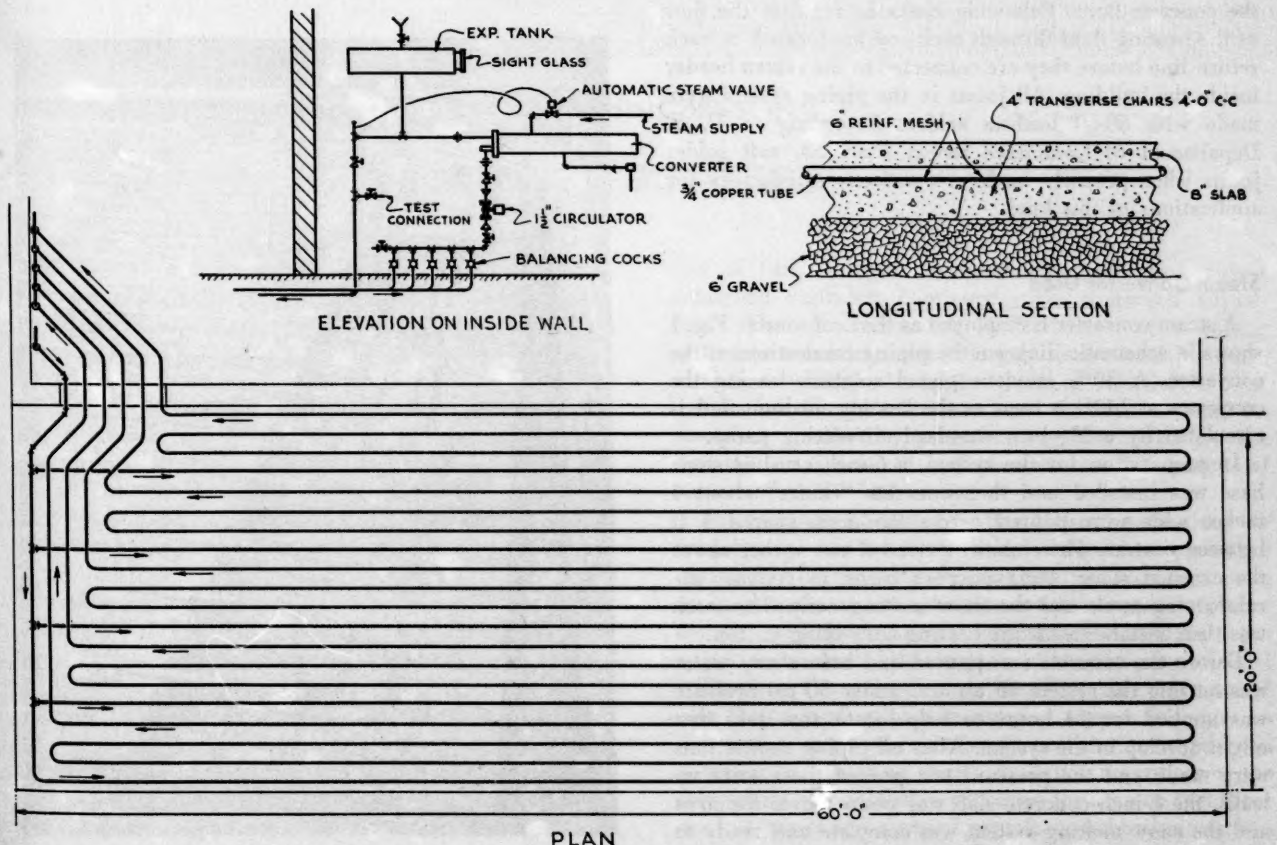

Fig. 1. Piping layout of the snow melting system, installation of the transverse chairs, and piping connections at the converter.

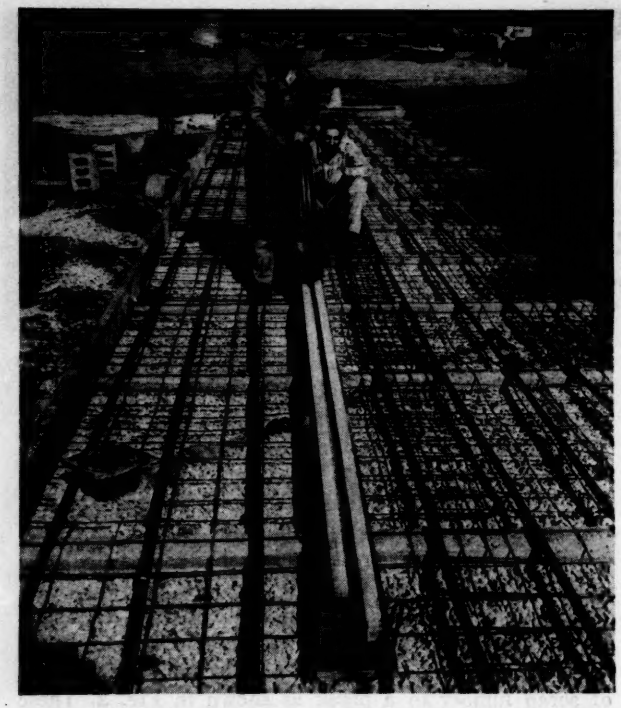

Fig. 2. Using the contractor's home-made guide for laying copper tube.

saved by using a wood or other template so as to make single 180° return bends.

The common supply header and the individual return lines from each coil are brought into the building under the concrete floor. Balancing cocks to regulate the flow of the heating fluid through each coil are located on each return line before they are connected to the return header inside the building. All joints in the piping system were made with 50-50 lead-tin solder. According to U. S. Department of Commerce report BMS 58, soft solder joints when properly made are perfectly satisfactory for applications of this kind.

Steam Converter Used

A steam converter is employed as the heat source. Fig. 1 shows in schematic diagram the piping connections at the converter. A 30% ethylene glycol solution leaving the converter at 140F is used as the heating medium and is circulated by a 1½-inch standard circulating pump.

In preparation for the system, a 6-inch crushed stone base was installed and then concrete "chairs" about 4 inches wide were poured across the area, spaced 4 ft between centers. These chairs extended two inches above the crushed stone, their purpose being to support the reinforcing mesh and the snow melting coils. The mesh was then installed with the heating coils lying on top.

Before the concrete was poured and before any water was let into the system an air test under 50 psi pressure was applied for 24 hours to help locate any leaks that might develop in the system. After all piping connections were made and the pressure test proved there were no leaks, the 8-inch concrete slab was poured over the area and the snow melting system was complete and ready to be placed in service.

Fig. 3. Portable mechanical bender used in making 180 deg bends.

The purpose of the water drains shown in Fig. 4 must not be misconstrued. These drains are for rain water drainage only, and are unnecessary for snow melting. When a snow melting system of this type is in operation, water does not accumulate, but evaporates rapidly. For that reason when designing level snow melting areas, no concern need be given to drainage. It is not uncommon in fact, to see a snow melted area completely dry even while snow is falling.

A fully automatic snow melting system, on call 24 hours of the day, is becoming more and more popular in areas where snow accumulation interferes with safe pedestrian and vehicular traffic.

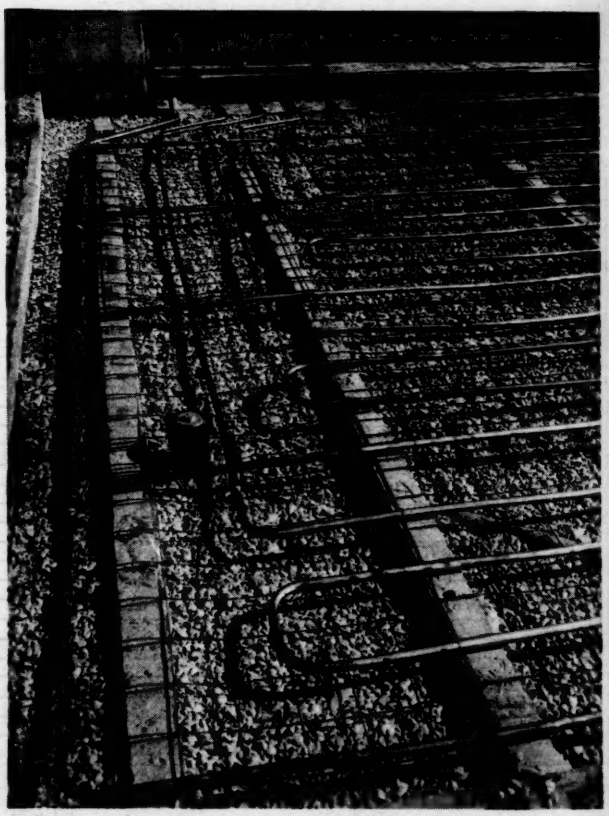

Fig. 4. Piping layout showing drains for rain water drainage.

COMBUSTION ANALYSIS SIMPLIFIED

F. W. HUTCHINSON

Professor of Mechanical Engineering
University of California, Berkeley, Cal.

Fundamental principles of the combustion process are set forth together with a clear explanation of making a mathematical interpretation of fuel analysis and Orsat readings. Practical, detailed examples are given.

THE basic task of a heating engineer (as, too, of the industrial heat-power engineer) is to establish an economical thermal path from an energy source to the place of energy utilization. For the heating engineer this path starts with the fuel and ends with the convector, radiator, grille, or panel which dissipates heat to the occupied space. The first process which occurs on this thermal path is that which takes place in the furnace or boiler: the liberation of energy from the fuel and its transfer to the air, or water, or steam which is to act as a working substance. The process of liberation, involving the combustion of fuel, affords one of the most significant opportunities, as well as one of the gravest hazards, for attaining efficient operation of a heating system. A 2% or 3% loss at any point in a heating system is important, but such a loss during combustion is of maximum importance since it then reflects a 2% or 3% increase in the gross cost of fuel. Further, the combustion process requires continued vigilance, continued care, continued adjustment. The effectiveness or ineffectiveness of a piping system or a heating unit is largely determined by static conditions which exist at the times of selection and of installation, but the effectiveness of the furnace—and its attendant combustion processes—is determined by the dynamic conditions of instantaneous air-fuel ratio and instantaneous air-fuel mixing.

The methods presented in this Reference Section are intended for use by the practical designer or operating engineer in determining, from known fuel characteristics, the most economical combustion conditions and in further determining, from known combustion conditions, the adjustments needed to improve the efficiency of fuel utilization. The procedure is based on the fundamental idea that regardless of how complex a given fuel may be it contains only two constituents—carbon and hydrogen —which have heating value; similarly, regardless of the complexity of combustion processes for a given fuel there are but two endproducts of complete combustion: carbon dioxide and water vapor. From these simple concepts

combustion equations are developed for a complex hydrocarbon and methods are established for a generalized analysis of combustion based on minimum determinations available from an Orsat-type flue gas analyzer.

The generalized equations and methods are believed to be unusually advantageous in that from them can be readily developed simplified equations and methods for *any* given fuel and for *any* conditions which occur during either complete or incomplete combustion. Five practical detailed numerical examples are presented to show typical methods of application of the results.

Chemical Energy in Fuels

Utilization of the chemical energy in fuels is based on the fact that various molecular arrangements possess differing degrees of stability and the less stable arrangements—under proper circumstances—will spontaneously undergo a change in the direction of greater stability. The situation is comparable to that existing on the side of a mountain where rocks of varying sizes and shapes have been deposited as a result of some long past geological upheaval. Some of the rocks will be in positions such that a minor disturbance will cause them to roll down the hill whereas others—though at an equal or greater height—will be so situated that great effort would have to be exerted to cause them to move to a lower level. In all cases, however, the potentiality of an action exists though in no case will any action occur until some outside force is exerted to destroy the state of unstable or metastable equilibrium (refer Fig. 1). The magnitude of the required external effect will vary from rock to rock, but once it has been exerted some spontaneous readjustment of position will take place.

In similar fashion the various chemical compounds are at different energy levels and their tendency—like that of the rocks—is to move toward a lower and more stable level. Here again, however, some initial energy *addition* is necessary to destroy the existing state of unstable or metastable equilibrium and thereby initiate the spontaneous re-arrangement in molecular structure with consequent increase in stability. Thus a piece of coal can be visualized as resting, thermally, at the bottom of a volcanic crater. In order for the coal to spontaneously combine with oxygen and thereby move down the thermal hill it is first necessary that sufficient energy be supplied from an external source to lift it over the rim of the crater; in thermodynamic practice this initial thermal lifting corresponds to the heating of the fuel up to the self-ignition temperature.

Even if coal is not heated, however, it will slowly combine with oxygen and thereby reach a state of greater stability. In order for this thermodynamic change to be comparable to the analogy previously established, it would be necessary to visualize that the rocks resting on the side of the mountain might be slowly sinking through the surrounding material. Thus the rock in the volcanic cone may seek a lower level by slow settling through the base material or, conceivably, it could pass through a "soft spot" in the wall of the cone and eventually achieve an exit followed by spontaneous descent.

From the engineering standpoint interest in chemical energy is largely concerned with: (1) Determination of the amount of added (activation) energy required to initiate a spontaneous process. (2) Investigation of paths to be followed and methods of partial control of the energy during the process. (3) Evaluation of the amount of energy which will be liberated by the material in question as it undergoes a movement toward a more stable state. Since chemical energy is a property it is evident that the answer to the last question—how much energy released?—will be the same irrespective of the path followed by the thermal rock as it rolls down the mountain.

Basic Fuels and Fuel Analysis

The only chemical reactions of interest in heat-power engineering are those which occur with the liberation of thermal energy; such reactions are said to be exothermic, in contrast with endothermic reactions which are accompanied by an absorption of thermal energy. Even among exothermic reactions engineering interest is limited to those which occur spontaneously and rapidly (after activation energy has been added) and those which liberate a relatively large amount of energy from materials which are available in sufficient quantity to permit maintenance of a continuous and economically practicable supply. Relatively few materials meet the above requirements; those which do are called *fuels* and it is particularly interesting—as well as somewhat surprising—to note that in the many varieties of solid, liquid, and gaseous fuels there are but two elements—carbon and hydrogen—which enter into reactions leading to liberation of thermal energy in amounts useful for engineering purposes. (Sulfur is capable of entering into such a reaction, but the resultant products of combustion are so difficult to handle mechanically and metallurgically that sulfur is not merely an unacceptable fuel, but a most undesirable material to have present—even in very small quantity—as a constituent of other fuels.)

All exothermic reactions involving carbon move in the direction of carbon dioxide as the limiting stable material, whereas reactions involving hydrogen move toward water as the stable end product; thus, regardless of what complex arrangements may exist between the carbon and the hydrogen (hydrocarbons) present in the original fuel, the resultant products following completion of the final heat liberating processes will necessarily be carbon dioxide and water. Differences between fuels are largely due to the combinations in which the carbon and hydrogen are originally present, the amount of free carbon being greatest in the geologically older solid fuels (as anthracite) and the fraction of hydrocarbons and free hydrogen being greatest in the geologically more recent gaseous fuels. Since the arrangement of molecules in the hydrocarbons determines the amount of stored chemical energy which they possess, it is evident that the thermal energy resulting from completion of an exothermic reaction will be determined in part by the original state of the materials which enter into the reaction.

When pure carbon combines with oxygen to form carbon dioxide the resulting heat liberation amounts to 14,150 Btu per pound; when pure hydrogen combines with oxygen to form water the resulting heat liberation (providing the resultant water is in liquid form and at the temperature of the entering constituents) is 61,000 Btu per pound. When hydrocarbons combine with oxygen

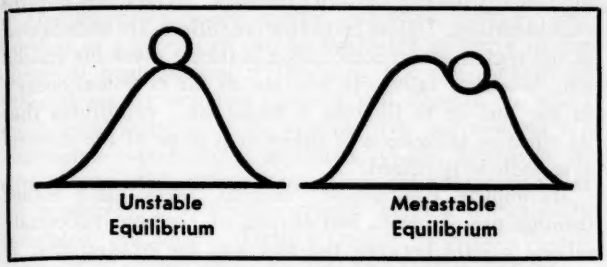

Fig. 1. Analogy showing chemical stability of fuels.

to form carbon dioxide and water, the heat liberation per pound of carbon and hydrogen originally present may be substantially less than the values for equal weights of these materials in the free state because of two factors: (1) The fact that some energy may have to be *added* to break up the original hydrocarbon. (2) The fact that oxygen originally present in the fuel is likely to already be combined with some of the hydrogen or carbon. Relatively, however, differences in heating values per pound of either carbon or hydrogen present are small and the major differences in desirability of different types of fuels—as gasoline and coal, for example—arise from greater or less convenience with respect to ease of attaining release of chemical energy. Thus in very large measure it is the form of the fuel rather than its energy content that determines its relative value for engineering purposes.

The heating value of fuels is expressed in Btu per unit weight or unit volume; by definition the high heating value, HHV, is the amount of energy liberated as one unit of fuel combines with oxygen at the same temperature and produces combustion products which are then cooled back to the initial temperature with condensation of any water vapor. The low heating value, LHV, differs from the high only in that water vapor which forms during the chemical reaction is cooled to the initial temperature but not condensed. In an exact sense the heating values depend on the thermodynamic path (as constant pressure or constant volume) that is followed during the process of cooling the products of combustion, but the absolute differences are not great and for most cases in practice they can be neglected. An equation relating HHV and LHV can be written in terms of the latent heat of vaporization of water at the temperature of the entering and leaving materials, the fractional weight of hydrogen, w_h, present in the fuel, and the numerical coefficient 9 which indicates the relative weight of water vapor produced to weight of hydrogen originally present; thus,

$$\text{HHV} = \text{LHV} + 9w_h r \text{ Btu per lb} \qquad (1)$$

A fundamental requirement of any practicable fuel is that it liberate energy at a temperature sufficiently high to permit efficient conversion of heat to work, yet at a temperature sufficiently low so that the process of combustion can be isolated by means of refractory surfaces. Thus the ignition temperature—that temperature at which combustion becomes spontaneous—is a very important criterion of fuel effectiveness. For all solid fuels the ignition temperature of the contained fixed carbon will correspond closely to the ignition temperature of the fuel since volatile matter will very largely be driven off (though not ignited) before combustion of the solid material starts. Ignition temperature of fixed carbon varies with the type of fuel within which it is contained and is lower for bituminous coal (approximately 765F) than for anthracite (approximately 925F). Somewhat curiously the ignition temperatures of various kinds of volatile matter are higher than for solid carbon: for hydrogen the ignition temperature is 1100F whereas for carbon dioxide it is 1225F. Methane, CH_4, the major constituent of much manufactured gas, has an ignition temperature of 1200F. Liquid fuels have widely varying ignition temperatures: thus for heptane it is 500F whereas for isooctane (the anti-knock constituent in gasoline) it is 980F and for ethane, C_2H_6, it is 1000F.

All fuels contain three types of materials: combustible matter, moisture, and inert matter. The combustible fraction is separable into non-volatile fixed carbon and such volatile constituents as hydrogen, hydrocarbons C_xH_y, and possibly alcohols, $C_xH_yO_z$. The moisture may be either free—as that represented by "wet" coal—or "bound" water which is chemically associated with the fuel as a result of some process or reaction that occurred at the time of fuel formation. Inert matter may be either volatile, as nitrogen, or may be non-combustible mineral material either mechanically mixed with the fuel or bound within it. In estimating either the qualitative or quantitative characteristics of a particular fuel, information is needed concerning both the amount and the kind of materials that make up the combustible and the non-combustible fractions.

The *ultimate* analysis of a fuel gives the percentage by weight of carbon, hydrogen, sulfur, oxygen, nitrogen, moisture, and ash. On the ultimate basis the moisture reported is free moisture only, the bound being reported in the percentages of hydrogen and oxygen. All of the oxygen present in the fuel may not be bound in water molecules—thus some oxygen might be present in molecules of alcohol—but by far the greater part is as moisture and the customary procedure in estimating heating value is to assume that *all* oxygen present is combined with hydrogen as water. Thus the weight fraction of hydrogen reported in the ultimate analysis should be split into two parts: the fraction of hydrogen which is combined with oxygen and is, therefore, valueless as fuel and the fraction which is uncombined (or combined with carbon in some form of carbohydrates) and therefore contributes to the heating value. Since water is 1/9 by weight hydrogen it follows that the weight of combined hydrogen in the fuel will be equal to $\frac{1}{8}$ of the weight of oxygen hence the weight of useful hydrogen in a fuel containing H_2 total pounds of hydrogen and O_2 total pounds of oxygen will be,

$$\text{Weight useful hydrogen} = H_2 - O_2/8 \text{ lb} \qquad (2)$$

The approximate heating value of any fuel (neglecting energy absorbed or released in breaking down carbohydrons) is therefore,

$$\text{HHV} = 14{,}150C + 61{,}000(H_2 - O_2/8) + 4{,}000S \text{ Btu per lb} \qquad (3)$$

where C, H_2, O_2, S are the weight fractions (based on one pound of fuel with contained moisture and ash) of the elements indicated. Since the heating value of hydrogen is so much greater than that of carbon it follows that the unit weight heating value of fuels which are high in hydrogen (natural gas and light oils, for example)

will be much greater than the heating value of such fuels as coal or charcoal.

Determination of the ultimate analysis is a relatively complex chemical procedure, but only from such an analysis can sufficient data be obtained to permit quantitative investigation of the combustion processes for a given fuel. For the most part, however, the variation in ultimate analyses of fuel samples from the same region is not very great and representative values of such analyses are available from practically all of the commercially important coal, oil, and natural gas regions.

A *proximate* fuel analysis is less costly than an ultimate and can be made with less equipment and in a shorter time. Except for use in supplying data needed for the combustion calculations a proximate analysis provides sufficient information to permit accurate evaluation of the firing characteristics of a particular fuel. Just as in the ultimate, a proximate analysis reports ash and moisture, but the remaining constituents of the fuel are grouped under the two headings of fixed carbon and volatile matter; included in the volatile matter is any nitrogen or other inert gas which may be present in the fuel together with all of the hydrocarbons, alcohols (if any are present) and other volatile combustibles. The major weakness of a proximate analysis is that it gives no indication of the quality of the materials making up the volatile fraction; here again, however, the variation in composition of volatile matter in fuel from a given location is not great hence standard values of ultimate and proximate analyses provide satisfactory means of interpreting fuel characteristics from the proximate analysis of a particular sample.

Basically, all fuels are "packages" of chemical energy and the differences among them are with respect to the quantity of energy contained (heating value), the ease with which the energy can be released from storage (combustion characteristic), and the cost. Additional factors include ignition temperature, steadiness of combustion (thus avoidance of engine "knocking"), avoidance of undesirable combustion products (as sulfuric acid formed during the combustion of sulfur), and a minimum of troublesome residue (as ash from the burning of coal).

Liberation of Chemical Energy: Combustion

By far the greater number of thermodynamic paths now of practical utility start with energy in chemical storage and end with useful work. The first step on the path connecting these end points is to achieve liberation of the chemical energy. The means by which this is accomplished is called combustion and it consists of a self-sustaining process during which carbon and hydrogen combine with oxygen under rapid but controlled conditions. Since chemical energy is a property, it follows that the amount of heat liberated during complete combustion of a given weight of fuel will be independent of the time required for the combustion process. Thermodynamically, the process of combustion is of very little interest because—so long as it is carried out under conditions which allow completion and which permit liberation of energy at a suitably high temperature—the end point is independent of the path. In engineering terms, however, many factors influence the *rate* of combustion and the temperature at which heat liberation occurs, hence in order to assure maintenance of adequate control with consequent effective utilization of the liberated energy the combustion processes and methods require consideration. Unless favorable conditions are maintained in the region where combustion is taking place the results may be either failure to liberate all the chemical energy in the fuel or to liberate it under such conditions that its effective utilization in subsequent steps of the conversion path is impaired.

Incomplete combustion generally takes place either through use of insufficient oxygen or because inadequate mixing occurs between the fuel and the oxygen that is supplied. The usual end product of incomplete combustion is carbon monoxide; since the heating value of carbon monoxide is only 3960 Btu/lb (as against 14150 Btu/lb for the reduction of carbon to carbon dioxide) it is evident that this material as an end product is a direct indication of marked fuel losses. In the great majority of practical combustion problems the difficulties involved in realizing satisfactory mixing between the fuel and the air supply are so great that it becomes necessary to provide an excess weight of air, per unit weight of fuel, in order to assure complete combustion. From a thermal standpoint excess air is not disadvantageous since the number of Btu released during complete combustion of one pound of fuel are independent of the weight of air supplied during the combustion process (providing only that the air supply exceeds the minimum requirements), but the effect of excess air is to dilute the products of combustion and thereby reduce their temperature so that extraction, for useful purposes, of thermal energy from these products becomes increasingly difficult and hence reduces the possibility of achieving a substantial conversion from thermal energy to useful work.

The need for excess air in practical combustion equipments arises primarily because of the very great difficulty in achieving satisfactory mixing between the raw materials: the fuel and the air. In the case of solid fuels it is evident that combustion can occur only at the interface between fuel and air hence the more pulverized the condition of the fuel the more effective will be the mixing of fuel with air and the more complete the process of combustion. With liquid fuels the situation is not different and the objective of fuel preparation is to break up the liquid into globules so small that the large surface-volume ratio will assure a satisfactory rate of combustion; since liquid fuels consist largely of volatile hydrocarbons, the combustion process occurs only after vaporization of the liquid hence the need is to provide a large surface from which vaporization can occur. With gaseous fuels the vaporization step is eliminated hence the opportunity for achieving effective combustion with a minimum of excess fuel is at a maximum.

The usual process of combustion is necessarily inefficient because of the fact that oxygen is not supplied directly, but rather as a constituent (21% by volume) of atmospheric air. Thus some 79% of the material which enters the furnace with the fuel consists of nitrogen or other inert gases and passes through the furnace—and the process of combustion—without making any thermal contribution, but with absorption of a significant amount of the energy liberated from the fuel. The excess air acts as a diluent and thereby reduces the temperature of the combustion process; in many cases this reduction is necessary and desirable for structural and metallurgical reasons, but thermodynamically it always is disadvantageous.

The potentialities of energy liberation during combustion of a given fuel can be evaluated in terms of the chemical composition of the fuel, but the amount of thermal energy actually released will depend on many mechanical features of the system; it is not unusual for incomplete combustion to occur (with discharge of carbon monoxide rather than carbon dioxide) even when air is supplied in quantities greater than the theoretically indicated minimum. Thus a major problem in the engineering application of the combustion process is that of achieving release of chemical energy under conditions which assure an adequate, but not excessive, supply of oxygen.

Analysis of Combustion

The analyses of engineering significance in connection with the process of combustion are of two different types. The first type includes analyses which precede the actual combustion process and which serve to indicate what the fuel and air requirements of the thermodynamic cycle are and how they can best be met. Thus in preliminary design of any thermodynamic cycle which is to utilize and convert thermal energy released from a fuel the first need is to determine how much energy is required and how much fuel must be consumed in providing this quantity of energy. A second, but not independent requirement, is that of either determining or—by design—establishing the temperature at which liberation of the chemical energy will occur.

The second type of analysis is based on experimental determination of the conditions which exist after an actual combustion process has taken place; from such known conditions it is possible to work backwards and thereby investigate the effectiveness of the process. Analyses of this kind require experimental knowledge concerning the constituents present by weight or by volume in the products of combustion, and the temperature of these products. One of the most commonly used methods of obtaining this information is by means of an Orsat analyzer which selectively achieves absorption in various chemical solutions of the thermodynamically significant gases present in the products of combustion.

In using an Orsat a representative sample of exhaust gas must first be obtained. This sample, of known volume and saturated with water vapor, is then placed in the analyzer under conditions which assure absorption by a potassium hydroxide solution of all of the carbon dioxide present in the sample; the resultant shrinkage in volume is indicative of the volumetric fraction of this gas which is present in the exhaust gases. The remaining combustion products are then brought in contact with a solution of pyrogallic acid which absorbs any free oxygen which may be present; remaining volume is once again measured and shrinkage, as compared with the volume of the original sample, is indicative of the volumetric fraction of carbon dioxide plus oxygen originally present in the combustion products. A third absorption then occurs of carbon monoxide by a solution of cuprous chloride. Since the original sample was assumed to be saturated with water vapor and since the volume shrinks during the absorptions it is evident that the volume of the original weight of water vapor would tend to decrease with consequent tendency toward increase of the partial pressure of the water vapor; but at a given temperature the pressure cannot exceed its saturation value and since in this case the temperature is held constant it follows that, simultaneously with the absorption of the various constituents, there will be a condensation of water vapor in amount sufficient to maintain a fixed value of the partial pressure of the water vapor which remains in the sample. Thus an Orsat analysis gives results which are the same as though the sample were of dry gases.

The Pound-Mole

The fundamental unit of all combustion calculations is the pound-mole which is defined as that mass of any material which has a weight in pounds equal to the molecular weight of the substance. The materials most often considered in combustion are carbon, C, with a molecular weight of 12, Hydrogen, H_2, with molecular weight of 2, oxygen, O_2, with 32, and nitrogen, N_2, with 28. For all but the most exact combustion calculations the molecular weight and other properties of the mixture of gases, other than oxygen, which make up air can be taken as identical with those of nitrogen; hence, for combustion analyses, air is treated as though it consisted of but two gases: 21% by volume of oxygen and 79% by volume of nitrogen (or 23.1% by weight oxygen and 76.9% by weight nitrogen).

$$\text{Pound-mole of air} = 0.231 \times 32 + 0.769 \times 28 = 28.92 \text{ lb}$$

The practical usefulness of the pound-mole arises from the fact that for material in gaseous form the volume of a pound-mole, at any given temperature and pressure, is the same for all materials and the number of molecules in a pound-mole is likewise the same for all materials; at standard atmospheric pressure and 32F the volume of one pound-mole of any substance in gaseous form is 358.6 cubic feet. Thus when combustion equations are written in terms of pound-moles the number of molecules going into the reaction are indicated by the number of pound-moles involved (though this number need not be the same on both sides of the equation) whereas the actual weights of material entering and leaving are, of course, necessarily the same.

In writing combustion equations various units are often used and in some cases more than one type of unit may be used in a single equation. To avoid confusion, careful differentiation must be noted in the use of symbols representing various constituents of both the fuel and of the products of combustion. The following nomenclature is used through this article:

(1) Italics, CO_2, represents per cent by weight.
(2) Bold-face, $\mathbf{CO_2}$, represents per cent by volume.
(3) Subscripts f and a refer, respectively, to fuel and air: Thus $(\mathbf{CO_2})_f$ would indicate percentage by volume of carbon dioxide in the fuel whereas $(N_2)_a$ would indicate percentage by weight of nitrogen in the air.
(4) Primed italics, C', represents weight fraction of the constituent in the fuel ($= C_f/100$).
(5) Standard type, CO_2, represents the constituent without units. Thus total weight in pounds would be shown as 80 lb CO_2. Total volume (or weight) in moles would be shown as 80_m CO_2.
(6) Combustion equations for the Orsat analysis are

often based on 100 pounds of dry exit gases; in this case the italicized symbol, CO_2, indicates the weight in pounds of the constituent present in 100 pounds of dry exit gases.

Equations for Complete Combustion of Carbon

Utilizing the pound-mole concept the basic equation for the complete combustion of carbon can be written as,

1 pound-mole carbon + 1 pound-mole oxygen = 1 pound-mole carbon dioxide or,

$$1_mC + 1_mO_2 = 1_mCO_2 \quad (4)$$

Then substituting the weights of a pound-mole of each substance, equation (4) can be re-written as

$$1(12)\text{ lb C} + 1(32)\text{ lb } O_2 = 1(12 + 32)\text{ lb } CO_2$$
$$12\text{ lb C} + 32\text{ lb } O_2 = 44\text{ lb } CO_2$$
$$1\text{ lb C} + 2.667\text{ lb } O_2 = 3.667\text{ } CO_2 \quad (5)$$

which shows that 2.667 pounds of oxygen are required to bring about the complete combustion of one pound of free carbon.

In most thermodynamic cycles, however, the oxygen is supplied as part of atmospheric air. Since air consists of 21% oxygen by volume and since equal gas volumes—at the same temperature and pressure—represent equal fractions of a pound-mole it follows that 0.79/0.21 = 3.76 pound-moles of nitrogen will accompany each pound-mole of oxygen and 4.76 pound-moles of air will have to be supplied to provide one pound-mole of oxygen. Equation (4) then becomes,

$$1_mC + 4.76_m(\text{Air}) = 1_mCO_2 + 3.76_mN_2$$

or

$$1_mC + (1_mO_2 + 3.76_mN_2) = 1_mCO_2 + 3.76_mN_2 \quad (6)$$

Substituting in the weights of pound-moles,

$$1(12)\text{ lb C} + (32 + 3.76 \times 28)\text{ lb Air} = 1(12 + 32)\text{ lb } CO_2 + 3.76 \times 28\text{ lb } N_2$$
$$12\text{ lb C} + 137.3\text{ lb Air} = 44\text{ lb } CO_2 + 105.3\text{ lb } N_2$$
$$1\text{ lb C} + 11.44\text{ lb Air} = 3.66\text{ lb } CO_2 + 8.78\text{ lb } N_2 \quad (7)$$

hence 11.44 lb of air are needed to burn 1 lb of carbon.

As previously discussed complete combustion cannot be achieved unless some excess air is provided. If X% excess air is supplied equation (6) becomes,

$$1_mC + 4.76_m(1 + X/100)_m(\text{Air}) = 1_mCO_2 + 3.76(1 + X/100)_mN_2 + (X/100)_mO_2 \quad (8)$$

giving,

$$1\text{ lb C} + 11.44\ (1 + X/100\text{ lb (Air)} = 3.66\text{ lb } CO_2 + 8.78(1 + X/100)\text{ lb } N_2 + (X/100)2.667\text{ lb } O_2 \quad (9)$$

hence for these generalized combustion conditions the weight of air required per pound of free carbon is 11.44(1 + X/100) and the total weight of the products of combustion is equal to the sum of the weight of fuel and air or,

$$11.44(1 + X/100) + 1\text{ lb products per lb carbon} \quad (10)$$

The per cent by weight of the materials present in the products of combustion is then,

$$CO_2 = 100\{3.66/[11.44(1 + X/100) + 1]\}\% \quad (11)$$
$$O_2 = 100\{[(X/100)2.667]/[11.44(1 + X/100) + 1]\}\% \quad (12)$$
$$N_2 = 100\{[8.78(1 + X/100)]/[11.44(1 + X/100) + 1]\}\% \quad (13)$$

For the special case of zero excess air the above equations reduce to,

$$CO_2 = 100(3.66/12.44)\% = 29.42\% \quad (14)$$
$$O_2 = 0\% \quad (15)$$
$$N_2 = 100(8.78/12.44)\% = 70.58\% \quad (16)$$

In many practical cases analyses on a volume basis are of greater value than on a weight basis; based on the above weight equations for combustion of free carbon:

(1) The volume of air required per pound of carbon burned (based on the specific volume, 13.35 cu ft/lb of standard air) is,

$$\text{Cu ft per lb of carbon} = (13.35)(11.44)(1 + X/100) \quad (17)$$

which, for zero excess air, becomes,

$$\text{Cu ft per lb of carbon} = 153\text{ cu ft} \quad (18)$$

(2) The volume of the products of combustion is determined by the number of pound-moles which they represent. From equation (8) the total pound-moles in the products of combustion amount to,

$$1 + 3.76(1 + X/100) + X/100 = 4.76(1 + X/100)$$

pound-moles per pound-mole of C. Since one pound-mole of any material occupies the same volume as one pound-mole of any other material the percentages by volume of the materials making up the products of combustion are,

$$\mathbf{CO_2} = 100\{1/[4.76(1 + X/100)]\}\% \quad (19)$$
$$\mathbf{O_2} = 100\{(X/100)/[4.76(1 + X/100)]\}\% \quad (20)$$
$$\mathbf{N_2} = 100[3.76(1 + X/100)]/[4.76(1 + X/100)] \quad (21)$$

and for the special case of zero excess air,

$$\mathbf{CO_2} = 21\% \quad \mathbf{O_2} = 0\% \quad \mathbf{N_2} = 79\% \quad (22)$$

The total volume of the products of combustion can be evaluated from the perfect gas law for partial pressure of P psfa, absolute temperature of T deg R = (deg F + 460), and the universal gas constant of R′ = 1544; thus,

$$V = mR'T/P \quad (23)$$

where m = number of moles of material entering into the reaction. The partial pressure is equal to the ratio of the pound-moles of the particular constituent divided by the pound-moles of all the products of combustion. Then selecting CO_2 as the particular constituent the partial pressure [using mole values from equation (8)] is,

$$\{1/[1 + 3.76(1 + X/100) + (X/100)]\}(14.7)(144)$$

psfa. Hence the volume of the products of combustion at a temperature of 2000 deg R is

$$V = (1)(1544)(2000)/\{1/[1 + 3.76(1 + X/100) + X/100)]\}(14.7(144) \quad (24)$$

and for the special case of zero excess air,

$$V = 3088000[(1/(4.76)\ (14.7)\ (144)] = 3088000/445 = 6940\text{ cu ft per lb} \quad (25)$$

Incomplete Combustion of Carbon

By analogy with the equations for complete combustion, the equations can be written for burning of carbon to carbon monoxide.

$$1_mC + 0.5_mO_2 = 1_mCO \quad (26)$$

$$12(\text{lb C}) + 0.5(32)(\text{lb } O_2) = 28(\text{lb CO})$$

$$1(\text{lb C}) + 1.33(\text{lb } O_2) = 2.335(\text{lb CO}) \quad (27)$$

which shows that 1.33 pounds of oxygen are needed to burn carbon to monoxide. For burning with excess air the equation becomes,

$$1\ (\text{lb C}) + 5.72(1 + X/100)\ (\text{lb air}) = 2.335(\text{lb CO}) + 4.39(1 + X/100)\ (\text{lb } N_2) + (X/100)\ (1.33)\ (\text{lb } O_2) \quad (28)$$

Combustion Equations for Hydrogen

By analogy with the equations for free carbon, the combustion equations for hydrogen can be written as follows:

$$2_mH_2 + 1_mO_2 = 2_mH_2O \quad (29)$$

$$2(2)\text{ lb } H_2 + 1(32)\text{ lb } O_2 = 2(2 + 16)\text{ lb } H_2O$$

$$4\text{ lb } H_2 + 32\text{ lb } O_2 = 36\text{ lb } H_2O$$

$$1\text{ lb } H_2 + 8\text{ lb } O_2 = 9\text{ lb } H_2O \quad (30)$$

which shows that 8 pounds of oxygen are required to accomplish the complete combustion of one pound of hydrogen.

With air,

$$2_mH_2 + 4.76_m(\text{Air}) = 2_mH_2O + 3.76_mN_2 \quad (31)$$

or,

$$2_mH_2 + (1_mO_2 + 3.76_mN_2) = 2_mH_2O + 3.76_mN_2 \quad (32)$$

$$2(2)\text{ lb } H_2 + (32 + 3.76 \times 28)\text{ lb Air} = 2(2 + 16)\text{ lb } H_2O + 3.76 \times 28\text{ lb } N_2$$

$$4\text{ lb } H_2 + 137.3\text{ lb Air} = 36\text{ lb } H_2O + 105.3\text{ lb } N_2$$

$$1\text{ lb } H_2 + 34.32\text{ lb Air} = 9\text{ lb } H_2O + 26.32\text{ lb } N_2 \quad (33)$$

With X% excess air,

$$2_mH_2 + 4.76(1 + X/100)_m(\text{Air}) = 2_mH_2O + 3.76(1 + X/100)_mN_2 + (X/100)_mO_2 \quad (34)$$

$$1\text{ lb } H_2 + 34.32(1 + X/100)\text{ lb Air} = 9\text{ lb } H_2O + 26.32(1 + X/100)\text{ lb } N_2 + (X/100)8\text{ lb } O_2 \quad (35)$$

When the fuel contains oxygen it is customary to assume that this oxygen combines with the hydrogen; the above reaction equations are then applicable to the combustion process with $(H_2 - O_2/8)$ substituted for H_2 as indicative of the weight of hydrogen that is free to combine with oxygen of the air.

The percent by weight of the materials present in the products of combustion is,

$$H_2O = 100\{9/[1 + 34.32(1 + X/100)]\}\%\text{ by weight} \quad (36)$$

$$O_2 = 100\{(X/100)8/[1 + 34.32(1 + X/100)]\}\%\text{ by weight} \quad (37)$$

$$N_2 = 100\{[26.32(1 + X/100)]/[1 + 34.32(1 + X/100)]\}\%\text{ by weight} \quad (38)$$

For the special case of zero excess air the above equations reduce to,

$$H_2O = 100(9/35.32) = 25.5\% \quad (39)$$

$$O_2 = 0\% \quad (40)$$

$$N_2 = 100(26.32/35.32) = 74.5\% \quad (41)$$

On a volume basis:

(1) The volume of standard air required per pound of hydrogen burned is,

Cu. ft per lb of hydrogen $= (13.35)(34.32)(1 + X/100)$ (42)

which for zero excess air becomes,

Cu ft per lb of hydrogen = 458 cu ft (43)

(2) The percentage volumes of the products of combustion are,

$$\mathbf{H_2O} = 100\{2/[1 + 4.76(1 + X/100)]\}\% \quad (44)$$

$$\mathbf{O_2} = 100\{(X/100)/[1 + 4.76(1 + X/100)]\}\% \quad (45)$$

$$\mathbf{N_2} = 100\{[3.76(1 + X/100)]/[1 + 4.76(1 + X/100)]\}\% \quad (46)$$

and for the special case of zero excess air,

$$\mathbf{H_2O} = 34.7\%;\ \mathbf{O_2} = 0\%;\ \mathbf{N_2} = 65.3\% \quad (47)$$

The total volume of the products of combustion based on the volume of the water vapor at its partial pressure and for a temperature of 2000°R, is,

$$V = (2)(1544)(2000)/\{2/[1 + 4.76(1 + X/100)]\}(14.7)(144) \quad (48)$$

and for the special case of zero excess air,

$$V = 6176000/(2/5.76)(14.7)(144) = 6176000/734 = 8400\text{ cu ft}/2\text{ moles of } H_2 \text{ or } 2100\text{ cu ft/lb of } H_2 \quad (49)$$

Combustion Equations for Hydrocarbon

Combining the equations already developed for combustion of free carbon or of hydrogen, the equations for any hydrocarbon, having the formula C_xH_y, can be written

$$1_mC_xH_y + (x + y/4)_mO_2 = (y/2)_mH_2O + x_mCO_2 \quad (50)$$

$$(12x + y)\text{ lb } C_xY_y + (x + y/4)(32)\text{ lb } O_2 = (y/2)(2 + 16)\text{ lb } H_2 + (x)(12 + 32)\text{ lb } CO_2$$

$$1\text{ lb } C_xH_y + 32(x + y/4)/(12x + y)\text{ lb } O_2 = 9y/(12x + y)\text{ lb } H_2O + 44x/(12x + y)\text{ lb } CO_2 \quad (51)$$

For combustion with air,

$$1_mC_xH_y + 4.76(x + y/4)_m\text{Air} = (y/2)_mH_2O + x_mCO_2 + 3.76(x + y/4)_mN_2 \quad (52)$$

$$1\text{ lb } C_xH_y + \{11.44[12x/(12x + y)] + 34.32[y/(12x + y)]\}\text{lb Air} = 9y/(12x + y)\text{lb } H_2O + (3.66)(12)(x)/(12x + y)\text{ lb } CO_2 + \{8.78[12x/(12x + y)] + 26.32[y/(12x + y)]\}\text{ lb } N_2 \quad (53)$$

For combustion with excess air the air and nitrogen terms in the above equations are multiplied by $(1 + X/100)$ and the oxygen term is multiplied by $(X/100)$,

$$1_mC_xH_y + 4.76(1 + X/100)(x + y/4)_m(\text{Air}) = (y/2)_mH_2O + x_m\,CO_2 + 3.76(1 + X/100)(x + y/4)_mN_2 + (X/100)(x + y/4)_mO_2 \quad (54)$$

and,

$$1\text{ lb } C_xH_y + (1 + X/100)\{11.44[12x/(12x + y)] + 34.32[y/(12x + y)]\}\text{ lb Air} = 9y/(12x + y)\text{ lb } H_2O + (3.66x)/(12x + y)\text{ lb } CO_2 + (1 + X/100)\{8.78[12x/(12x + y)] + 26.32[y/(12x + y)]\}\text{ lb } N_2 + (X/100)\{[32(x + y/4)]/(12x + y)\}\text{ lb } O_2 \quad (55)$$

which is of the form,

$$1 \text{ lb } C_xH_y + A \text{ lb Air} = B \text{ lb } H_2O + C \text{ lb } CO_2 + D \text{ lb } N_2 + E \text{ lb } O_2 \quad (56)$$

where the coefficients A,B,C,D, and E have fixed values for a given fuel when burned with a given percentage by weight of excess air. The per cent by weight of the materials present in the products of combustion is,

$$H_2O = 100[B/(B + C + D + E)]\% = 100[B/1 + A)]\% \text{ by weight} \quad (57)$$

$$CO_2 = 100[C/(B + C + D + E)]\% = 100[C/(1 + A)]\% \text{ by weight} \quad (58)$$

$$N_2 = 100[D/(B + C + D + E)]\% = 100[D/(1 + A)]\% \text{ by weight} \quad (59)$$

$$O_2 = 100[E/(B + C + D + E)]\% = 100[E/(1 + A)]\% \text{ by weight} \quad (60)$$

The volume relationships for this fuel are obtained from the basic combustion equations in exactly the same way as was used in the sections on carbon and on hydrogen, thus,

$$H_2O = 100\{(y/2)/[(y/2) + X + 3.76(1 + X/100)(X + y/4) + (X/100)(X + y/4)]\}\% \text{ by volume} \quad (61)$$

$$CO_2 = 100\{X/[(y/2) + X + 3.76(1 + X/100)(X + y/4) + (X/100)(X + y/4)]\}\% \text{ by volume} \quad (62)$$

$$N_2 = 100\{[3.76(1 + X/100)(X + y/4)]/[(y/2) + X + 3.76(1 + X/100)(X + y/4) + (X/100)(X + y/4)]\}\% \text{ by volume} \quad (63)$$

$$O_2 = 100\{[(X/100)(X + y/4)]/[(y/2) + X + 3.76(1 + X/100)(X + y/4) + (X/100)(X + y/4)]\}\% \text{ by volume} \quad (64)$$

and for the special case of zero excess air,

$$H_2O = 100\{(y/2)/[(y/2) + X + 3.76(X + y/4)]\}\% \quad (65)$$

$$CO_2 = 100x/[(y/2) + X + 3.76(X + y/4)]\% \quad (66)$$

$$N_2 = 100(3.76)(X + y/4)/[(y/2) + X + 3.76(X + y/4)]\% \quad (67)$$

$$O_2 = 0\% \quad (68)$$

The total volume of the products of combustion based on the volume of carbon dioxide at its partial pressure and for 2000°R is,

$$V = (x)(1544)(2000)/\{x/[(y/2) + X + 3.76(1 + X/100)(x + y/4) + (X/100)(x + y/4)]\}\text{cubic feet per mole of } C_xH_y \quad (69)$$

For the special case of zero excess air the above equation becomes,

$$V = 3088000/\{(14.7x1.44)/[(y/2) + X + 3.76(x + y/4)]\}\text{cubic feet per mole of } C_xH_y \quad (70)$$

Combustion Analyses from Orsat Readings

In most actual combustion processes the determination of air-fuel ratio cannot be made by direct measurement of entering air since various leakages through auxiliary openings and through the furnace setting will be responsible for a substantial increase in total air over that entering at the burner. Thus for practical purposes the air-fuel ratio must usually be determined by calculation from data available on analysis of the products of combustion. The usual Orsat analysis gives carbon dioxide, carbon monoxide and oxygen and from these data—together with a knowledge of the N_2 and O_2 content of the fuel—it is possible to carry through a satisfactorily complete analysis of combustion conditions and to determine—if this is not already known—the carbon and hydrogen content of the fuel. All analyses of this type utilize the concept of a mass balance, and by establishing such balances on nitrogen, carbon, hydrogen, and oxygen complete combustion information can be obtained.

When the ultimate analysis of the fuel is known, or when the percentage by either volume or weight of the carbon or the hydrogen in the fuel is known, the analysis in terms of Orsat data requires fewer steps than for the generalized case in which the only information available concerning the composition of the fuel is the percentage of N_2 and of O_2 that it contains. Since the latter case is the most complex and since all other cases can be treated as special and simplified forms of the same analysis, the general procedure will be established in detail.

Consider that some unknown fuel is burned under combustion conditions such that the Orsat reading, in volumetric percentages on a dry gas basis, is,

Carbon dioxide = CO_2 % by volume
Carbon monoxide = CO % by volume
Oxygen = O_2 % by volume

If the fuel contained sulfur the resultant sulfur dioxide would appear as part of the Orsat reading for carbon dioxide. Since a pound-mole of either carbon (12 pounds) or of sulfur (32 pounds) will react with the pound-mole of oxygen it follows that the volume of sulfur dioxide in the exit gases will be exactly the same as the volume of carbon dioxide that would have resulted if an equal fraction of a mole of carbon were burned in place of the sulfur. When the fuel contains only a very small amount of sulfur the analysis can be made with reasonable accuracy by assuming that all of the indicated carbon dioxide is due to combustion of carbon alone; when a larger, and known, percentage of sulfur is present in the fuel an approximate analysis can be made by adding 12/32 of the known weight of sulfur to the weight of carbon and thereafter continuing the analysis as though no sulfur were present. If greater accuracy is needed and if the weight of sulfur in the fuel is known, the equivalent amount of sulfur dioxide can be deducted from the Orsat reading for carbon dioxide.

For the burning, with adequate air, of any commercial fuel in a furnace there will not be any significant amount of hydrogen or of other gaseous combustible in the products of combustion. For burning of hydrocarbons in an internal combustion engine, however, combustibles will almost always be present in the exit gases. Extensive research reported by the National Advisory Committee of Aeronautics (Reports 476 and 616) shows that for either gasoline or diesel fuel the amount of hydrogen present in the exit gases bears a fixed relationship to the amount of carbon monoxide and can be taken as 51% of the volumetric fraction of carbon monoxide reported in Orsat reading. The same source gives 0.22% as the amount of methane, by volume on a dry gas basis, that is usually found in the exit gases from an internal combustion engine. If there is evidence that other hydrocarbons are present in the products a modified type of Orsat analysis can be used to determine the fractions of saturated and unsaturated hydrocarbons in an exit-gas sample; aside, however, from research studies, it is rarely necessary to carry out the more complicated modified Orsat analysis.

Then adjusting the original Orsat readings and assuming—with good accuracy—that the undetermined remaining volume of the products of combustion consists of nitrogen, we have

Carbon dioxide	$= CO_2$
Carbon monoxide	$= CO$
Oxygen	$= O_2$
Hydrogen	$= 0.51CO$
Methane	$= 0.22$
Nitrogen	$= N_2$

Since most of the desired results are on a weight rather than volume basis a first step is to convert the volumetric data on exit gas to a gravimetric basis; thus,

$$\text{Carbon dioxide} = CO_2(12 + 32)/W = CO_2(44/W) = CO_2\ \%\ \text{by weight} \quad (71)$$

$$\text{Carbon monoxide} = CO(12 + 16)/W = CO(28/W) = CO\ \%\ \text{by weight} \quad (72)$$

$$\text{Oxygen} = O_2(32/W) = O_2(32/W) = O_2\ \%\ \text{by weight} \quad (73)$$

$$\text{Hydrogen} = CO(2 \times 0.51) = CO(1.02)/W = H_2\ \%\ \text{by weight} \quad (74)$$

$$\text{Methane} = 0.22(12 + 4)/W = 3.5/W = CH_4\ \%\ \text{by weight} \quad (75)$$

$$\text{Nitrogen} = N_2(28/W) = N_2(28/W) = N_2\ \%\ \text{by weight} \quad (76)$$

$$W = (44CO_2 + 28CO + 32O_2 + 1.02CO + 0.35 + 28N_2)/100 \quad (77)$$

where W is the total molecular weight of exit gas.

A reaction equation can then be written in the form,

$$(\text{lb C} + \text{lb H}_2 + \text{lb O}_2 + \text{lb N}_2)_f + (\text{lb O}_2 + \text{lb N}_2)_a \quad (78)$$

$$= 100 + \text{lb H}_2\text{O} \quad (79)$$

where each term is in units of pounds per 100 pounds of dry products of combustion and the subscripts f and a refer to fuel and air respectively; terms in the form "lb X" represent unknowns and it will be noted that in its present form the equation contains seven such. In order to completely solve the reaction equation two of the unknowns must be given; usually the fuel is known to be free of, or to possess known percentages by weight of oxygen and nitrogen. A complete generalized solution can be obtained by considering that the fractions by weight of nitrogen and oxygen in the fuel, N' and O', respectively, are known.

Let Z equal the weight of fuel burned per 100 pounds of dry products of combustion; then

$$Z = (\text{lb C} + \text{lb H}_2 + \text{lb O}_2 + \text{lb N}_2)_f = (\text{lb C} + \text{lb H}_2 + O'_2Z + N'Z)_f = (\text{lb C} + \text{lb H}_2)_f/(1 - O' - N') \quad (80)$$

Now establish a mass-balance on the nitrogen entering and leaving the combustion space,

$$(\text{lb N}_2)_a + N'Z = \text{N}_2$$

or

$$(\text{lb N}_2)_a = \text{N}_2 - N'Z \quad (81)$$

hence

$$(\text{lb N}_2 + \text{lb O}_2)_a = (1/0.769)(\text{N}_2 - N'Z) \quad (82)$$

Four of the original unknowns in the reaction equation can now be eliminated; substituting from equations (80) and (82) into (78) and simplifying,

$$[(\text{lb C} + \text{lb H}_2)_f/(1 - O' - N')][1 - (N'/0.769)] + (\text{N}_2/0.769) = 100 + (\text{lb H}_2\text{O}) \quad (83)$$

Equation (83) contains three unknowns (lb C)$_f$, (lb H$_2$)$_f$, and (lb H$_2$O); two of these can be eliminated by establishing mass balance on the hydrogen and the carbon:

A mass-balance on the hydrogen gives,

$$(\text{lb H}_2)_f = (4/16)CH_4 + H_2 + (2/18)(\text{lb H}_2\text{O}) = 0.25CH_4 + H_2 + 0.111\ (\text{lb H}_2\text{O}) \quad (84)$$

where (lb H$_2$O) is the only unknown on the right side of the equation.

A mass-balance on the carbon gives,

$$(\text{lb C})_f = (12/44)\ CO_2 + (12/28)CO + (12/16)CH_4 = 0.2727CO_2 + 0.429CO + 0.75CH_4 \quad (85)$$

which does not contain any unknowns on the right side.

Substituting from equations (84) and (85) into equation (83),

$$\{[0.2727CO_2 + 0.429CO + 0.75CH_4 + 0.25CH_4 + H_2 + 0.111(\text{lb H}_2\text{O})][1 - N'/0.769)] \div [(1 - O' - N')]\} + N_2/0.769 = 100 + (\text{lb H}_2\text{O})$$

which simplifies to,

$$(\text{lb H}_2\text{O}) = \{(0.2727CO_2 + 0.492\,CO + CH_4 + H_2)\ [1 - (N'/0.769)]/(1 - O' - N') + (N_2/0.769) - 100\}\{(1 - O' - N')/(0.889 - O' - 0.857N')\} \quad (86)$$

in which there are no unknowns on the right side; thus equation (86) provides a solution for the weight of water vapor in the exit gases per 100 pounds of *dry* exit gases as determined by Orsat analysis. Knowing (lb H$_2$O) the weight of carbon and of hydrogen in the fuel can be calculated from equations (84) and (85), the weight of fuel from equation (80), and the weight of air from equation (82); the actual fuel-air ratio can then be determined by simple division.

The air required for perfect combustion (no excess air) is given by,

$$(\text{lb Air})/(\text{lb Fuel}) = 11.44C' + 34.32H'_2 - (1.0/0.231)O'_2 \quad (87)$$

where C', H'_2, and O'_2 are the fractions by weight in the fuel on a moisture and ash free basis; these fractions are readily calculable from data available from the above analysis. Then by division of the fuel-air ratio for perfect combustion into the fuel-air ratio for actual combustion the fraction of excess air used can be readily determined.

In practical application of the above method of analysis it must be noted that the calculated weight of carbon in the fuel, (lb C), is equal to that weight of carbon which undergoes combustion to form either CO_2 or CO. If any carbon leaves the system in smoke or with the ash it will *not* show up in the analysis and the derived value of the per cent by weight of carbon in the moisture and ash-free fuel will then be less than the actual value. If information is available as to either the weight of carbon lost as smoke or in ash, or the fraction of total carbon from the fuel which is so lost, the data resulting from the analysis can be revised to give the actual per cent by weight of each constituent of the moisture-free and ash-free fuel. If information is available concerning the per cent moisture and the per cent ash in the fuel the data from the analysis can be further developed to permit evaluation of the ultimate analysis of the fuel on an as-received basis. The steps in these various extensions of the analysis are as follows:

(1) To determine the *per cent* by weight of constituents in the moisture-free and ash-free fuel (assuming no loss of carbon in smoke or ash).

$$\% \text{ Carbon} = (\text{lb C/Z})\,100 = 100C' \quad (88)$$
$$\% \text{ Hydrogen} = 100(\text{lb } H_2/Z) = 100H'_2 \quad (89)$$
$$\% \text{ Oxygen} = 100(O'_2) \quad (90)$$
$$\% \text{ Nitrogen} = 100N'_2 \quad (91)$$

(2) To determine the per cent by weight *of constituents* in the moisture-free and ash-free fuel when the combined loss of carbon in the smoke or with the ash is known to be C_{loss} pounds per hundred pounds of fuel fired.

$$\% \text{ Carbon} = 100(100C' + C_{loss})/(100 + C_{loss}) \quad (92)$$
$$\% \text{ Hydrogen} = 100H'_2/(100 + C_{loss}) \quad (93)$$
$$\% \text{ Oxygen} = 100(O'_2)/(100 + C_{loss}) \quad (94)$$
$$\% \text{ Nitrogen} = 100N'_2/(100 + C_{loss}) \quad (95)$$

(3) To determine the per cent by weight of constituents in the fuel on an as-received basis; the per cents by weight of moisture and of ash are known and are respectively equal to 100M and 100A.

$$\% \text{ Carbon} = 100(100C' + C_{loss})/(100 + C_{loss} + 100M + 100A) \quad (96)$$
$$\% \text{ Hydrogen} = 100H'_2/(100 + C_{loss} + 100M + 100A) \quad (97)$$
$$\% \text{ Oxygen} = 100(O'_2)/(100 + C_{loss} + 100M + 100A) \quad (98)$$
$$\% \text{ Nitrogen} = 100N'_2/(100 + C_{loss} + 100M + 100A) \quad (99)$$
$$\% \text{ Moisture} = 100M$$
$$\% \text{ Ash} = 100A$$

Combination Analysis for Simplified Cases

The generalized solution established in the preceding section covers the most involved applications of Orsat data to fuel-and-combustion analysis. In by far the greater number of practical combustion problems, a number of simplifying conditions greatly facilitate the numerical work needed in obtaining a solution. Thus for steady state combustion processes (as in furnaces) no correction need be made to the Orsat reading for either methane or hydrogen. In many cases the fuel will be known to be free of either oxygen or nitrogen or both and in many other cases the percentage by weight of carbon in the fuel may be known. Analyses for the various simplified cases can be made either by direct derivation or by reduction of the generalized solution. The latter procedure will be illustrated for some of the more common cases:

Case I. Fuel contains no oxygen. Equation (86) reduces to,

$$(\text{lb } H_2O) = \{(0.2727CO_2 + 0.429CO + CH_4 + H_2)[1 - (N'/0.769)]/(1 - N') + (N_2/0.769) - 100\}\{(1 - N')/(0.889 - 0.857N')\} \quad (100)$$

and equation (80) reduces to,

$$Z = (\text{lb C} + \text{lb } H_2)_t/(1 - N') \quad (101)$$

Equations (84) and (85) remain unchanged.

Case II. Fuel contains no nitrogen. Equation (86) reduces to,

$$(\text{lb } H_2O) = [(0.2727CO + 0.429CO + CH_4 + H_2)/(1 - O') + (N_2/0.769) - 100][(1 - O')/(0.889 - O')] \quad (102)$$

and equation (80) reduces to,

$$Z = (\text{lb C} + \text{lb } H_2)_t/(1 - O') \quad (103)$$

Equations (84) and (85) remain unchanged.

Case III. Fuel contains neither oxygen nor nitrogen. Equation (86) becomes,

$$(\text{lb } H_2O) = [(0.2727CO_2 + 0.429CO + CH_4 + H_2) + (N_2/0.769) - 100]/0.889 \quad (104)$$

and equation (80) reduces to,

$$Z = (\text{lb C} + \text{lb } H_2) \quad (105)$$

Equations (84) and (85) remain unchanged.

Case IV. Carbon content of the fuel is known. When the fraction by weight, C', of carbon in the fuel is known the procedure is to calculate the weight of carbon from equation (85) and then determine the weight of fuel as,

$$Z = (1/C')\,(\text{lb C}) \quad (106)$$

For the known O' and N' the weights of oxygen and nitrogen can then be calculated and the weight of hydrogen in the fuel (per 100 pounds of dry products of combustion) obtained by subtraction. Equation (82) then gives the weight of air supplied and the weight of water vapor formed during combustion is known as 9 times the weight of hydrogen in the fuel.

Case V. Carbon content of fuel known, no oxygen or nitrogen in the fuel, and no hydrogen or methane in the products of combustion. The weight of carbon in the fuel is obtained from a simplified form of equation (85) as,

$$\text{lb C} = 0.2727CO_2 + 0.429CO \quad (107)$$

and the weight of hydrogen in the fuel is then,

$$\text{lb } H_2 = (1 - C')/C'(\text{lb C}) \quad (108)$$

The weight of air is $(N_2/0.769)$ and the weight of water vapor is $9(\text{lb } H_2)$.

Examples of Combustion Calculations

The following numerical examples illustrate the method of applying the procedures developed in the preceding sections.

Example 1. An anthracite coal having 1.3% nitrogen and 3.9% oxygen (on a gravimetric ash and moisture free basis) is burned without smoke and without loss of free carbon in the ash. The products of combustion, by Orsat analysis, contain 14.6% carbon dioxide, 0.2% carbon monoxide, 5.5% oxygen, and—by difference—79.7% nitrogen; the fuel is assumed to contain no appreciable quantity of sulfur. Determine the percentages of carbon and hydrogen in this coal, determine the fuel-air ratio, and evaluate the supply of excess air to the furnace.

Solution: The volumetric Orsat percentages will first be changed to a gravimetric basis; from equation (77),

$$W = [44(14.6) + 28(0.2) + 32(5.5) + 28(79.7)]/100 = (642 + 5.6 + 176 + 2230)/100 = 30.54$$

hence,

$CO_2 = 44(14.6/30.54) = 21.0\%$ by weight
$CO = 28(0.2/30.54) = 0.2\%$ by weight
$O_2 = 32(5.5/30.54) = 5.8\%$ by weight
$N_2 = 28(79.7/30.54) = 73.0\%$ by weight

Substituting in equation (86)

$$(\text{lb } H_2O) = \{[0.2727(21.0) + 0.429(0.2)][1 - (0.013/0.769)]/(1 - 0.039 - 0.013) + (73.0/0.769) - 100\}\{(1 - 0.039 - 0.013)/[0.889 - 0.039 - 0.857(0.013)]\} = 1.07 \text{ lb}$$

From equation (84),

$$(\text{lb } H_2)_f = 0.111(1.07) = 0.119 \text{ lb}$$

From equation (85),

$$(\text{lb C})_f = 0.2727(21.0) + 0.429(0.2) = 5.81 \text{ lb}$$

From equation (80),

$$\text{Weight of fuel} = Z = (5.81 + 0.119)/(1 - 0.012 - 0.029) = 6.25 \text{ lb}$$

From equation (82),

$$\text{Weight air} = (1/0.769)[73.0 - 0.013(6.25)] = 93.65$$

$$(\text{Air-fuel ratio})_{\text{actual}} = 93.65/6.25 = 15.0$$

On an ash and moisture free basis the percentages by weight of constituents in the fuel are:

$C = (5.81/6.25)100 = 92.9\%$ by weight in fuel
$H_2 = (0.119/6.25)100 = 1.9\%$ by weight in fuel
$N_2 = 1.3\%$ by weight in fuel
$O_2 = 3.9\%$ by weight in fuel
100.0%

The required air-fuel ratio for perfect combustion is then, from equation (87),

$$(\text{Air-fuel ratio})_{\text{perfect}} = 11.44(0.929) + 34.32(0.019) - [(1.0/0.231)](0.039) = 11.1 \text{ lb}$$

The actual air supply is therefore $15.0/11.1 = 1.35$ times the requirements for perfect combustion; excess air is thus equal to 35%.

Example 2. A gaseous fuel is known to contain 70.4% nitrogen by weight and 24.4% oxygen. When burned in a furnace the Orsat analysis shows 83.9% nitrogen, 9.1% oxygen, and 7.0% carbon dioxide. Determine the carbon and hydrogen content of the fuel (on an ash and moisture free basis), the air-fuel ratio and the percentage of excess air supplied under the actual conditions of combustion.

Solution: Changing the volumetric Orsat percentages to a gravimetric basis, from equation (77),

$$W = [44(7.0) + 32(9.1) + 28(83.9)]/100 = (308 + 292 + 2350)/100 = 29.5$$

hence,

$CO_2 = 44(7.0/29.5) = 10.4\%$ by weight
$O_2 = 32(9.1/29.5) = 10.0\%$ by weight
$N_2 = 28(83.9/29.5) = 79.6\%$ by weight
100.0%

Substituting in equation (86),

$$(\text{lb } H_2O) = \{[0.2727(10.4)][1 - (0.704/0.769)]/(1 - 0.244 - 0.704) + (79.6/0.769) - 100\}\{(1 - 0.244 - 0.704)/[0.889 - 0.244 - 0.857(0.704)]\} = 10.1 \text{ lb}$$

From equation (84),

$$(\text{lb } H_2)_f = 0.111(10.1) = 1.122 \text{ lb}$$

From equation (85),

$$(\text{lb C})_f = 0.2727(10.4) = 2.837 \text{ lb}$$

From equation (80),

$$\text{Weight of fuel} = Z = (2.837 + 1.122)/(1 - 0.244 - 0.704) = 76.1 \text{ lb}$$

From equation (82),

$$\text{Weight air} = (1.0/0.769)[79.6 - 0.704(76.1)] = 33.8 \text{ lb}$$

$$\text{Air-fuel ratio} = 33.8/76.1 = 0.444$$

On an ash and moisture free basis the percentages by weight of the constituents of the fuel are:

$C = (2.837/76.1) = 3.73\%$ by weight in fuel
$H_2 = (1.122/76.1) = 1.47\%$ by weight in fuel
$O_2 = 24.4\%$ by weight in fuel
$N_2 = 70.4\%$ by weight in fuel
100.0%

The air-fuel ratio required for perfect combustion is then, from equation (87),

$$(\text{Air-fuel ratio})_{\text{perfect}} = 11.44(0.0373) + 34.32(0.0147) - (1/0.231)(0.244) = 0.931 - 1.057 = -0.126 \text{ lb}$$

which indicates that the oxygen content of the fuel is more than sufficient to permit complete combustion hence no air is required.

The above results can be checked by noting that all of the oxygen in the air must appear in the exit gases and an additional 0.126 pound of oxygen will appear in the exit gases for each pound of fuel burned. The total weight of free oxygen in the exit gases is then,

$$\text{Free exit gas oxygen} = 0.231(33.8) + 0.126(0.231)(76.1) = 10.0 \text{ lb}$$

But the weight of dry exit gases is 100 lb hence the oxygen content is 10% by weight which is in agreement with the percentage determined from the Orsat data.

Although the knowledge of constituents in the fuel which is realized from the above analysis is of interest it does not permit evaluation of the heating value since no information can be gained as to the chemical arrangements which exist among the elements. Thus the carbon can be partially present in a free state or in the form of carbon monoxide, carbon dioxide, or methane. Additional data concerning the fuel would be therefore necessary before its heating value could be determined.

Example 3. An anthracite coal has the following composition on an ash and moisture free basis:

$C = 92.9\%$
$H_2 = 1.9\%$
$N_2 = 1.3\%$
$O_2 = 3.9\%$

If this coal is burned without smoke and without loss of carbon to the ash determine the volumetric percentage of constituents in the actual products of combustion. Determine the percentages of nitrogen, carbon dioxide, and

oxygen that would be shown in an Orsat test of the exit gases. Assume that 35% excess air is supplied.

Solution: The reaction equation for the carbon (based on 100 pounds of fuel) is obtained by substitution into equation (9),

$$92.9[1(\text{lb C}) + 11.44(1.35)(\text{lb air})] = 92.9[3.66(\text{lb } CO_2) + 8.78(1.35)(\text{lb } N_2) + 2.667(0.35)(\text{lb } O_2) =$$
$$92.9(\text{lb C}) + 1435(\text{lb air}) = 340(\text{lb } CO_2) + 1101(\text{lb } N_2) + 86.8(\text{lb } O_2)$$

The reaction equation for the hydrogen is obtained by substitution in equation (35), and noting that the net weight of hydrogen which receives oxygen from the air is $H_2 - O_2/8$,

$$\left[1.9 - \frac{3.9}{8}\right][1(\text{lb } H_2) + 34.32(1.35)(\text{lb air})]$$
$$= \left[1.9 - \frac{3.9}{8}\right][9(\text{lb } H_2O) + 26.32(1.35)(\text{lb } N_2) + 8(0.35)(\text{lb } O_2)]$$
$$1.41(\text{lb } H_2) + 65.4(\text{lb air}) = 12.7(\text{lb } H_2O) + 50.2(\text{lb } N_2) + 3.95(\text{lb } O_2)$$

Adding the reaction equations for carbon and hydrogen and adding also nitrogen and oxygen that is in the coal and the hydrogen that combines directly with oxygen,

$$92.9(\text{lb C}) + 1.9(\text{lb } H_2) + 1.3(\text{lb } N_2) + 3.9(\text{lb } O_2) + 1500(\text{lb air}) = 340(\text{lb } CO_2) + [12.7 + 3.9(9/8)](\text{lb } H_2O) + 1152.5(\text{lb } N_2) + 90.8(\text{lb } O_2)$$

The relative volumes in the products of combustion will correspond to the relative number of pound-moles:

Carbon dioxide	=	340/44 =	7.73 lb moles
Water vapor	=	17.1/18 =	0.95
Nitrogen	=	152.5/28 =	41.15
Oxygen	=	90.8/32 =	2.84
			52.67

Hence the volumetric percentage of constituents in the exit gases is,

$$CO_2 = 100(7.73/52.7) = 14.7\% \text{ by volume}$$
$$H_2O = 100(0.95/52.7) = 1.8\% \text{ by volume}$$
$$N_2 = 100(41.15/52.7) = 78.1\% \text{ by volume}$$
$$O_2 = 100(2.84/52.7) = 5.42\% \text{ by volume}$$

The volumetric percentages indicated by an Orsat analysis would be,

$$CO_2 = 100(14.7/98.2) = 15.0\% \text{ by volume}$$
$$N_2 = 100(78.1/98.2) = 79.6\% \text{ by volume}$$
$$O_2 = 100(5.4/98.2) = 5.4\% \text{ by volume}$$

Example 4. For the coal of the above example consider that 1.35% of the total carbon in the fuel burns to carbon monoxide and determine the volumetric percentage of constituents in the actual products of combustion and in the products as indicated by an Orsat analysis.

Solution: The weight of carbon incompletely burned, per 100 pounds of fuel, is equal to,

$0.0135(92.9) = 1.25$ lb and the weight which undergoes complete combustion is $92.9 - 1.25 = 91.65$ lb. The two reaction equations for carbon are then (from equations 9 and 28)

$$91.65[1(\text{lb C}) + 11.44(1.25)(\text{lb air})] = 91.65(3.66(\text{lb } CO_2) + 8.78(1.35)(\text{lb } N_2) + 2.667(0.35)(\text{lb } O_2)]$$
$$1.25[1(\text{lb C}) + 5.72(1.35)(\text{lb air})] = 1.25[2.33(\text{lb CO}) + 3.39(1.35)(\text{lb } N_2) + 0.35(1.33)(\text{lb } O_2)]$$

The reaction equation for the hydrogen is exactly as in example 3. Simplifying the carbon equations and adding all three reaction equations, together with the nitrogen and oxygen in the fuel, and the hydrogen that combines directly with the oxygen,

$$92.9(\text{lb C}) + 1.9(\text{lb } H_2) + 1.3(\text{lb } N_2) + 3.9(\text{lb } O_2) + 1425(\text{lb air}) = 335.5(\text{lb } CO_2) + 2.9(\text{lb CO}) + 17.1(\text{lb } H_2O) + 1092(\text{lb } N_2) + 90.3(\text{lb } O_2)$$

The relative volumes in the products of combustion will correspond to the relative number of pound-moles:

Carbon dioxide	=	335.5/44 =	7.62
Carbon monoxide	=	2.9/28 =	0.10
Water vapor	=	16.1/18 =	0.95
Nitrogen	=	1092/28 =	39.00
Oxygen	=	90.3/32 =	2.80
			50.47

Hence the volumetric percentages of constituents in the exit gases is,

$$CO_2 = 100(7.62/50.47) = 15.08\%$$
$$CO = 100(0.10/50.47) = .20\%$$
$$H_2O = 100(0.95/50.47) = 1.88\%$$
$$N_2 = 100(39.0/50.47) = 77.30\%$$
$$O_2 = 100(2.8/50.47) = 5.54\%$$
$$100.00\%$$

The volumetric percentages indicated by an Orsat analysis would be,

$$CO_2 = 100(15.08/98.1) = 15.4\%$$
$$CO = 100(0.20/98.1) = 0.2\%$$
$$N_2 = 100(77.3/98.1) = 78.8\%$$
$$O_2 = 100(5.54/98.1) = 5.6\%$$
$$100.0\%$$

Example 5. Hexane (C_6H_{14}) is burned under conditions of perfect combustion of a hydrocarbon. Determine the air-fuel ratio.

Solution: By substitution in equation (53) for the combustion of a hydrocarbon,

$$1(\text{lb } C_6H_{14}) + [11.44\{12(6)/[12(6) + 14]\} + 34.32\{14/[12(6) + 14]\}](\text{lb air}) = 9(14)/[12(6) + 14](\text{lb } H_2O) + 3.66(6)/[12(6) + 14](\text{lb } CO_2) + 8.78[\{12(6)/[12(6) + 14]\} + 26.32\{14/[12(6) + 14]\}](\text{lb } N_2)$$
$$1(\text{lb } C_6H_{14}) + 15.17(\text{lb air}) = 1.465(\text{lb } H_2O) + 3.06(\text{lb } CO_2) + 11.53(\text{lb } N_2)$$

The air-fuel ratio for this hydrocarbon under conditions of perfect combustion is thus slightly greater than 15 to 1.

Theory vs. Practice in

Radiant Heating

T. NAPIER ADLAM

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Part 2. In this discussion of American and English practice concerning radiant heating, data are presented on the installation of copper tube in ceiling panels, placement of plaster, venting and elimination of air pockets. The author has long been associated with radiant heating and is regarded as an authority on the subject.

IN Part 1, my remarks were confined to some of the salient points relating to what can be termed the theory phase of the subject without delving into the question of present day practices. Therefore, I believe it is opportune to consider some of the present methods of application both here and in England, especially since some European engineers have been looking to America for ideas which will help to broaden their views and to assist them, in some measure, to develop less expensive methods. Here we have discovered many ways of manufacturing and applying radiant panels. While some of these methods are very ingenious and merit considerable credit, undoubtedly we have experienced a wave of cheap and inferior applications that every good heating engineer deplores.

As to ceiling panels, I agree entirely with the remarks made by H. H. Bruce of London, England, in his 1949 presidential address before the English Institution of Heating and Ventilating Engineers. He stated that it might be possible for English engineers to study American methods to see if they can adopt in England a method of constructing ceiling panels that is less expensive than the present practice. On the other hand, I am quite sure that American heating engineers would not wish English engineers, in making changes of their designs, to adopt some of the methods which have been used in this country without first giving full consideration to the advantages and disadvantages associated with such methods. I understand that it is customary for many clients in England to demand a 5-year guarantee against leaky coils and cracking of the plaster, which makes it essential for the heating contractor to take every precaution against such an eventuality, especially since a written guarantee in England really means something. In view of this, it may be of interest to examine the method usually used in England. Fig. 1 is a typical illustration of how these fabricated ceilings are installed.

Fabricated Ceilings in England

Expanded metal is first attached to the underside of the joists with the pipe coils suspended below, a method invariably recommended in America for all good work. While details in Fig. 1 are intended to be typical of a ceiling panel with expanded metal above and below the pipes, I understand it is found satisfactory to use slabcork, rocklath, or other similar material instead of the expanded metal above the pipes, or to support the pipes from an existing ceiling. After the pipe coils are placed in position and levelled correctly, plaster is applied to completely cover the pipes. The mixture actually surrounding the pipes is usually 1¼-inch thick, is applied in three rough layers, and consists of a sand-lime-Portland cement mixture reinforced with ox-hair. The three layers or coats are applied one after the other as soon as each is sufficiently firm and the three together are of sufficient thickness to thoroughly embed the pipes.

Plaster Coats

Another layer of expanded metal is then immediately applied to the underside of the plaster and secured by means of wires previously looped around the pipes. A rendering coat of the same mixture, 3/16 to ¼-inch thick, is now applied to the expanded metal with sufficient force to press the plaster through the expanded metal so it will adhere to the underside of the panel mixture. The surface of this coat is roughened to form a key and allowed to dry for several days before adding the "browning" or "floating" coat which is then applied ⅜ to ½-inch thick. In Britain, this is a sand-lime mixture also reinforced with cow-hair and made in small quantities for immediate use with plaster of Paris or with retarded hemihydrate gypsum plaster. The finishing coat, ⅛ to 3/16-inch thick, is then applied before the "floating" is dry. This finishing coat contains a large proportion of lime and has a surface reinforcement of ⅛-inch mesh jute canvas scrim. The plaster of Paris has a normal set of only 15 minutes. Hence the scrim

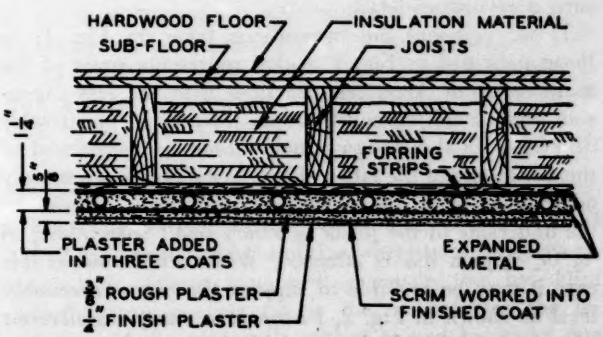


Fig. 1. Section between floor and ceiling showing English method of applying ceiling coils in plaster.

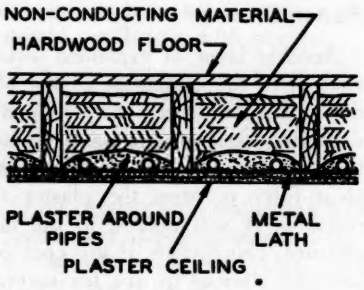
Fig. 2. Coils supported below expanded metal before applying plaster ceiling.

must be applied very quickly. This, undoubtedly, is a very reliable and durable method to guard against cracks, especially since the water temperature is invariably lower than the temperatures used in America.

American Practice

I know of many ceiling installations in America which have been in use for many years with no sign of plaster cracks or other trouble developing. The finished plastering was carried out without using scrim or any other special precautions except the usual care in the construction of the ceiling, and supporting the pipes in plaster above the expanded metal or rocklath so that the pipes may expand and contract without disturbing the finished plaster. In my opinion, this design would make a good substitution for the English method illustrated in Fig. 1, and it would be less expensive to construct. However, if one considers some of the cheaper methods used in America, then one would hesitate before making such a recommendation.

Fig. 3. Ceiling of wood construction with pipe between joists, and embedded in plaster above expanded metal.



If we compare the precautions taken in Fig. 1, to those indicated in Fig. 2, which represents some of the more common American practices with the less expensive type of ceiling construction, we find a considerable difference in the design which cannot be considered to the advantage of the latter. These installations are usually constructed with the expanded metal first secured to the underside of the joists to which small bore tubing of ⅜ or ½-inch dia is attached. While with considerable care it may be possible to support the pipes reasonably level as shown in Fig. 2, I have seen many installations where the tubing sags appreciably between the supports. Therefore some parts of the coil are covered to a reasonable thickness and other parts of the pipe are very close to the surface of the finished plaster.

Insufficient Heat

It seems that the whole question of ceiling panels which came in for a lot of discussion while I was in England, may well be considered at this time. While I have not encountered the poor quality work in ceiling panels as appears all too prevalent with floor panels, I have visited a number of residences where little or no heat has been forthcoming from the ceilings in some of the rooms, and occupants have been compelled to purchase and use electrical heaters to provide sufficient heat for their comfort.

I have seen cases in England where, in quite large institutions, electric heaters had to be employed in some wards to provide sufficient heat for comfort. However, in these cases the lack of heat was not due to inferior workmanship, but to insufficient panel surface which made it necessary to supplement the system with electrical heaters. I have observed many cracked ceilings over here and ceilings discolored, some due to the high water temperatures and some due to the closeness of the pipes to the plaster surface. Furthermore, it is not altogether uncommon to find jobs where, owing to the high temperature of the circulating water and nature of the plaster, we get a kind of snow storm effect as a chemical change or disintegrating effect takes place in the plaster, and flakes fall to the floor as snow.

Preferred Ceiling Panel Design

When dealing with plastered ceilings, I very definitely prefer to have the pipe coils placed above the expanded metal, either as shown in Fig. 3 or Fig. 4, rather than to have the pipes embedded in the finished plaster below the metal lath as illustrated in Fig. 5. It is not suggested that the designs shown in Fig. 3 and 4 are better than the British design shown in Fig. 1, but since the British design is certainly more costly to construct and the designs shown in Fig. 3 and 4 have proven eminently satisfactory for many years, I have no fear in making this recommendation. There may be some reasonable claim for electric conductors to be placed in the finished plaster, although manufacturers of electric conductors for radiant heating usually recommend that no other metallic reinforcing should be used at any point where

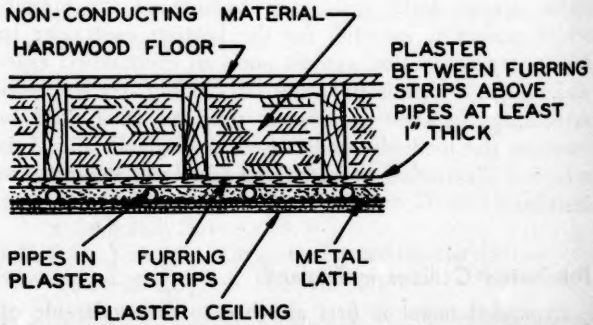


Fig. 4. Section through wood constructed ceiling. Pipes parallel to or at right angles to joists are supported by furring strips.

it will be crossed by the conductor, because of the hum generated in the wire when the heating element is on.

Placement of Tube in Ceiling Panels

As regards placing small copper tube below the metal lath, there appears to be a very definite line of demarkation on this question in the opinions of tube manufacturers. Apparently, some advocate the practice of placing tube below the expanded metal, believing that it can be made satisfactory; also that it provides a cheaper construction enabling them to compete with other types of low price heating systems. However, some tube manufacturers believe it is much safer to place the pipes above the expanded metal, especially (1) that so many workmen are unaccustomed to this type of work and (2) it is so easy for any faulty construction to bring discredit to both the system and the firm.

I know professional engineers who early in their dealings with radiant heating, always designed ceiling panels with the tube below the metal lath. They were compelled to give up this practice because of the trouble experienced, and they now insist on having the coils installed on similar lines to that shown in Fig. 3 or Fig. 4. With the tube installed below the expanded metal, there is not only concern over the possibility that air pockets may be formed but also that due to sagging pipes, the thickness of the finished plaster will vary considerably and will leave weak spots in the ceiling which may eventually develop into serious cracks. Since the ceiling surface has to be finished smooth and flat, the thickness of the finished plaster varies between a very thin layer below that portion of the tubing which sags most and the plaster between the pipes, especially where portions of the expanded metal may buckle upwards. This weakness is aggravated by strains and stresses created in the plaster as the tubing expands and contracts, due to temperature differences.

When the pipes are above the expanded metal, the finished plaster can be applied evenly over the whole ara of the metal lath, and there will be less weight for this plaster to support. It is, in my opinion, essential to apply plaster above and around the pipes in either case to facilitate conduction of the heat over the whole ceiling surface. Plaster above the metal lath may be of a coarser grade with cement added to increase its conductivity. The greater conductivity will allow the heat to travel faster over the spaces between the pipes, thereby giving a more equable surface temperature, and although any movement of the pipes due to expansoin or contraction may form small cracks in this plaster, it will not disturb the finish plaster as is the case when the tube

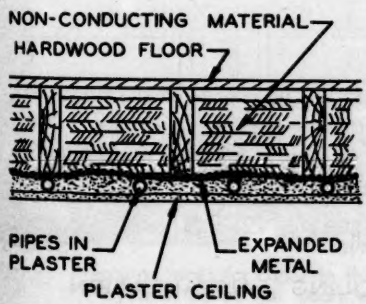


Fig. 5. Section through wood construction ceiling. Pipes are parallel to joists and embedded in plaster below expanded metal.

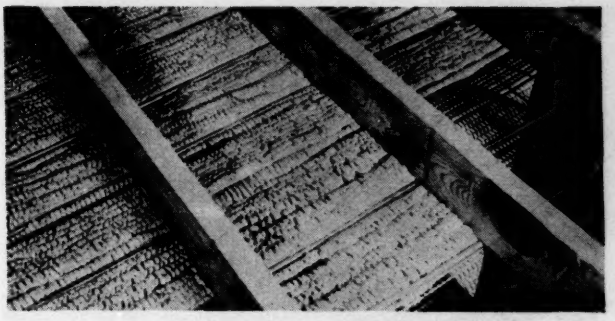


Fig. 6. Overhead view to show appearance of plaster in contact with tubes.

is placed below the metal lath and actually embedded in the finished plaster. Manufacturers who advocate placing the coils above the expanded metal claim that sufficient plaster can be forced through the expanded metal to practically cover the tubes so that they become fully effective. Fig. 6 is a photograph taken from above the ceiling showing how well the plaster can be made to cover the coils.

My own opinion is that since the upper surface of the coils can be substantially covered with plaster, as shown in Fig. 6, and seems to be made equally effective as regards heat transmission as coils placed below the expanded metal, the former is undoubtedly a more reliable method of installing the coils and is less prone to cracked ceilings. Even though it is possible to work the plaster up through the expanded metal to practically cover the pipes, I think it is very much better to thoroughly cover the pipes with plaster to a thickness of at least one inch above the top of the pipes, and to spread this plaster over the whole of the area between the joists. The results are: More heat transmtited per square foot of pipe surface, a more equable surface temperature over the ceiling area, less strain on any part of the finished plaster with very little chance of cracking, and less heat transmitted upwards to the roof. The latter is true, because when the pipes are fully covered, a lower water temperature will be necessary and less heat will be wasted.

In some cases, it may be found there are difficulties in getting the plaster to the space above the pipes after the expanded metal has been installed. However, since this plaster above the expanded metal may be added before the ceilings are finished, it is often possible to apply the plaster above the pipes before every available access is closed. With many of the ceiling installations I have designed, rocklath has been used below the pipes in place of the expanded metal, the plaster was applied as the work proceeded, and the pieces of rocklath were nailed to the joists. This method has proved to be eminently satisfactory in every way, with no trouble whatever with the heat transmission or cracking of the finished plaster, even though scrim has never been used.

Troubles Due to Air Pockets

Reverting to the question of trouble due to lack of heat, I have invariably found that where there has been an entire lack of heat from ceiling panels, this has been caused by air pockets left in the coils during the installation of the pipe coils, either caused by kinks due to careless workmanship or high spots allowed to exist

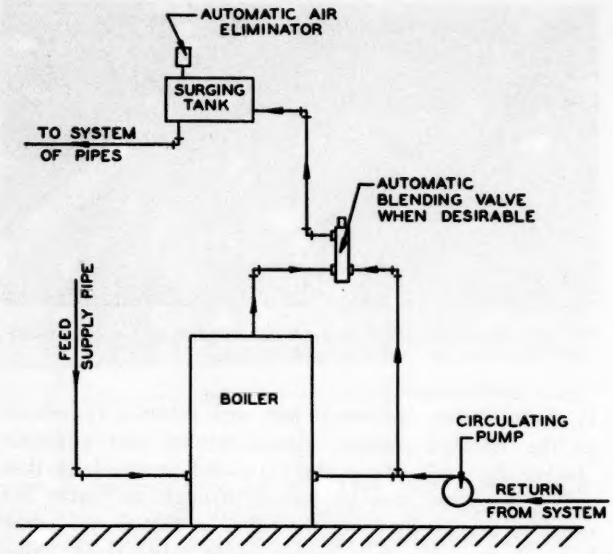


Fig. 7. Method of air venting at high level tank. This illustrates a very important point.

in the circuit pipe without any provision made for air venting. I cannot emphasize too strongly the question of air venting, because it is so inexpensive to correct this when installing the pipes, but afterwards it is often impossible to locate the air locks and to effect a permanent remedy without tearing down a lot of structure—invariably a major and very costly undertaking.

The idea that a higher lift circulating pump will overcome air locks often proves to be a fallacy. It is usually recommended or resorted to by inexperienced contractors to overcome faults which should not exist. While a high lift pump may help matters in some of the smaller installations, it is invariably found that even small air pockets will retard the circulation in those circuits affected and will create an unbalanced system. Then again, there are some types of air pockets which even a high lift pump will not be able to overcome, and it is impossible for any reliable engineer to condone such practices knowing that the unsuspecting customer has to pay much more for electric power and has an inferior job. The only sure method of preventing air trouble is to install and support all pipes and fittings so that no air pockets are formed during installation or can develop afterwards. I emphasize this point without any qualifications, because of the many failures I have examined over the number of years I have been directly associated with all types of heating systems.

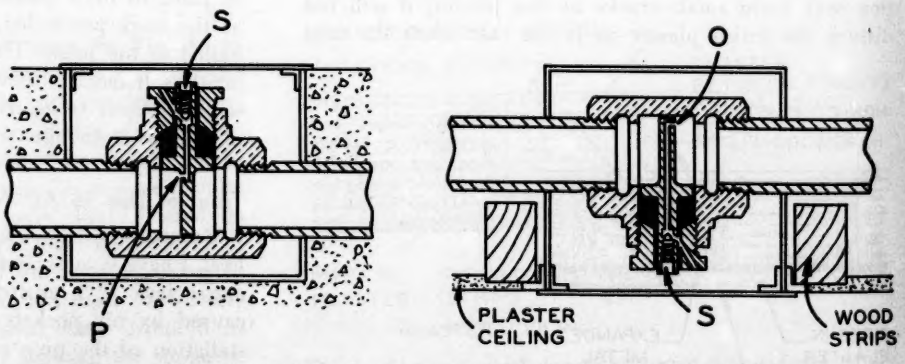
A very simple and inexpensive method of maintaining a well air vented system is to use a surging tank on the main flow pipe between the boiler and the coils as shown in Fig. 7. Since the continuity of the flow is interrupted as the water enters the tank, there is less chance for the air to be carried forward entrained with the water as is the case when an air vent pipe is simply connected to the main flow pipe. Since the air which becomes liberated from the water in the boiler rises as it enters the tank, it immediately becomes eliminated through the automatic air vent and in this way the system is gradually purged of all air, and other incondensible gases. There are several other good methods of extracting the air from the water after it leaves the boiler and before it enters the general circuits to be distributed throughout the system. I strongly recommend that one of these features be added to every system, large or small, regardless of whether or not other air vents are used throughout the system.

Balancing Device and Air Vent

With some types of flat roof construction, it is often difficult to install air vents above the ceiling coils, due to lack of space. There are, however, several types of air vents available for air venting the coils from within the pipes. Fig. 8 illustrates one of these fittings which is a combination balancing device and air vent. It is a fitting which can be easily installed in any part of the coil most conducive for eliminating the air, and may be used for both ceiling and floor coils.

For floor use, the balancing fitting is installed with the valve stem at the top as shown in the left view of Fig. 8. Any air which may accumulate in the pipe is allowed to escape from the top of the pipe through the orifice *P* and up through the hole in the stem of the valve when the stainless steel Allen screw *S* is slightly loosened. The stem of the valve can be turned independently to modulate the flow of water to the required amount for good regulation. For ceiling use, the balancing fitting is simply reversed and is installed with the valve stem at the bottom, as shown in the right view of Fig. 8. In this position the air is allowed to escape from the top of the pipe through the orifice *O* and down through the hole in stem of the valve when the Allen screw at the bottom is loosened.

Fig. 8. Sections of screwed type flow adjuster and air vent. Left, details for floor coils; right, view for ceiling coils.



Faulty and Inferior Work

Since I have called attention to the many faulty systems I have seen due entirely to air locks, I think it is only fair to heating contractors to say that sometimes the best methods of installing ceiling coils are often frustrated by the lack of foresight on the part of the architect, or the impracticability of the engineer's interpretation of roof design to meet the requirements of the heating contractor. Generally, however, by close cooperation between the architect and the heating contractor, a satisfactory method can be found, whereby a system can be installed which will prove efficient and durable, yet will not destroy the main architectural features of the building which the architect invariably wishes to retain. However, to allow a system to be installed with inherent faults which will develop into an expensive undertaking for the owner and perhaps prove totally inadequate for comfort conditions, is something to be deplored by everyone concerned.

This question of inferior work of which I speak, is not merely an obsession with me but a real thing which is now being brought to the attention of the householder by public bodies. As I write these sentiments, I have before me a copy of the real estate and building section of a daily paper published a short time ago, within 50 miles of where I write. On the front page, in large letters, appear these words: "If it's radiant, be sure it heats." below this headline appears the opinion of the local Chamber of Commerce.

In speaking of several local housing projects, where a large number of the houses have radiant heat, the vice-president states that "unsophisticated buyers snap up unquestioningly homes that have radiant heat, only to find too late that some radiant heat does not heat." For lack of space, it is impossible to relate more of the comments made, but I introduce this short excerpt from an article to show that people are getting tired of inferior methods of radiant heating and will naturally turn back to the other methods of providing comfort unless reliable systems of radiant heating are provided.

The article referred to contains no comments adverse to radiant heating in principle, but simply calls the attention of would-be buyers to the shoddy methods which were being practiced under the guise of radiant heating. Therefore, it seems to me that in trying to define what we mean when we speak of "practice" in connection with radiant heating, the problem becomes very complex because one man's practice may be another man's nightmare, and if we reflect on some of the methods adopted by heating engineers and plumbers in the past to provide some kind of comfort conditions, we are often amazed at the credulity of human nature. Yet these crude methods were evidently considered to be the practice of the trade in those days and today we sometimes find similarly crude ideas being used under the guise of radiant heating. Therefore, I would like to claim a little indulgence, and call attention to what I consider inferior work being done in connection with floor heating.

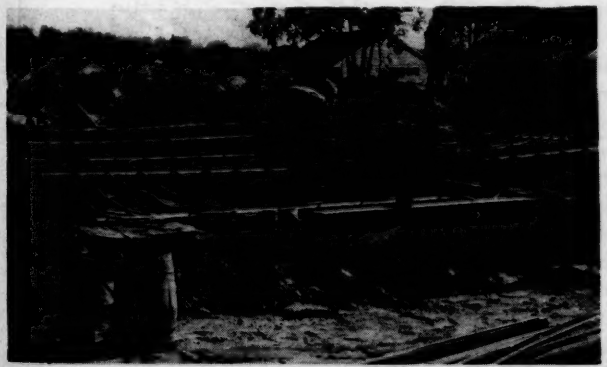


Fig. 9. Preparing pipes for concrete floor. Pipes are supported by and nailed to rough wood strips.

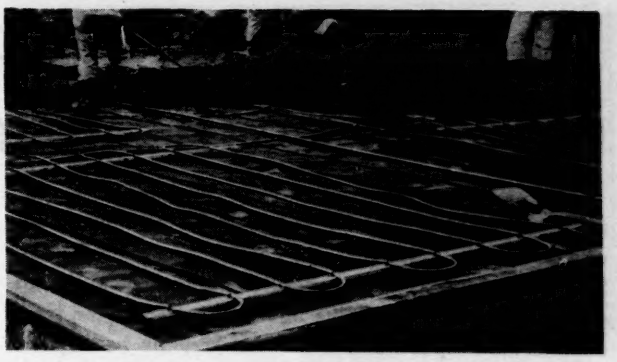


Fig. 10. Spreading concrete over uneven pipes. Condition is aggravated by careless workmen walking on pipes.

I sometimes wonder as I view some of these installations if those who are responsible for some of these crude practices ever read the legend of how the wild wood pigeon learned, or refused to learn from the thrush how to build its nest.

According to legend, the thrush had the theory and knowledge of how to build a good and durable nest, with a foundation of twigs, followed by smaller twigs, to which is added hay, grass and any other softer material which the thrush can find; then to finish with an inside lining of a plaster-like material, as many wild bird lovers in Europe know. He then set out to teach the pigeon. The pigeon listened for a while and then with characteristic impatience, repeated that old familiar phrase, "I know! I know! I know!" He then gathered the larger and smaller twigs and said, "To —— with the theory," and finished right there. The result was the wild pigeon's crude nest which he never did learn how to finish correctly to make a good job.

This may be only a legend, but it has a moral for all when we are considering how to do a job. I present photographs of floor coils in Figs. 9 and 10 to indicate what I mean when I refer to the legend of the wild pigeon. The illustrations are typical examples of work installed in a large number of houses that I have inspected.

Reliable heating engineers have for years held a theory on how pipes should be installed for floor and ceiling heating, a theory which has apparently proved quite satisfactory for many years. It will be unfortunate if while we are exercising a lot of energy in trying to count every heat ray leaving the heated panel, or trying to trace every heat ray around the room, we neglect to call attention to that most important phase, which I am afraid, has in many instances, brought ridicule to the heating profession.

Heat Loss Through Cavity-Wall Masonry

In recent years interest has increased in the advantages offered by cavity-wall masonry construction for buildings. Such a wall consists of an outer (facing) leaf, or wythe, of masonry separated from the interior backing wythe by a continuous air space 2 to 3 inches wide; the two wythes are generally bound together by cross ties of metal set in the wall as it is built. In order to determine the insulating value of the cavity wall compared to that of a solid wall, and to ascertain to what degree the ventilation of the wall with outdoor air might affect its insulating value, a number of heat transfer investigations have been made by the National Bureau of Standards Building Technology Division under the direction of Henry E. Robinson.

A MAJOR advantage of cavity-wall construction is provided by the air space, which prevents penetration to the inner face of rain water that may leak through joints and minute cracks in the outer face. In addition, the air space breaks the continuity of the masonry, which has relatively low resistance to heat flow, and adds considerably to the thermal insulating value of the wall.

Water penetrating the outer wythe of a cavity wall seeps or trickles down its inner face and, by means of flashings set in the wall during construction, is diverted outward through weep-holes or occasional open vertical joints between bricks in the outer face. Such flashings and weep-holes are provided at the bottom of the cavity above grade and over windows and other openings through the wall. The weep-holes constitute openings into the cavity at different levels through which outdoor air can circulate; furthermore, there may be other fortuitous openings in the outer or inner wythes, or at the top, which also may permit or promote air circulation through the cavity.

The heat-transfer measurements were made in the NBS vertical guarded hot-box heat-transfer apparatus on three different specimen walls 8 feet high and 5 feet wide. In this apparatus, one face of the wall is exposed to air at about 70F, and the other face to air at about 0F. By means of special equipment on the warm side, the heat flow through a centrally located and known area of the wall is determined. The temperatures of the air and wall surfaces are observed, thus enabling calculation of the heat-transfer coefficients of the wall.

Wall specimen A, the 8⅛-inch solid wall used for comparative data, was constructed of 8.1- by 3.6- by 2.3-inch clay bricks made from medium-strength soft mud, laid in common American bond with cement-line mortar, without finish on either face. There were alternately five stretcher courses and one header course.

Wall specimen B, Fig. 1, tested in various modifications designated as B1, B2, B3, and B4, was a brick cavity wall 9⅜ inches thick, with the brick facing and backing laid in stretcher courses and separated by an air space 2.1 inches wide. The wythes were connected by ¼-inch diameter, Z-shaped steel wall ties spaced about 22 inches apart at every sixth course. The cavity was sealed at the bottom, sides, and top leaving an effective cavity width of 4.2 feet. The brick and mortar were the same as those used for specimen A; there was no finish on either face. During construction, three bricks were omitted from the outside wythe at the third course, and three at the thirty-second course, leaving three openings into the cavity at the top and at the bottom of the wall spaced 86 inches apart vertically.

For the test of specimen B1, the openings were sealed completely with bricks and sponge rubber; in tests of specimens B2, B3, and B4, each opening was only partially closed, yielding aggregate openings of 4.2, 7.2, and 89.0 square inches area, respectively. These corresponded to ventilating openings of 1.0, 1.7, and 21.0 square inches area per linear foot of cavity length at the top and bottom of the wall. During the tests these openings permitted natural ventilation of the cavity.

Wall specimen C was a cavity wall 9¾ inches thick with brick facing, structural clay-tile backing, a 2¼-inch cavity, and steel wall ties spaced about 24 inches apart at every sixth course of brick. The 3.8- by 5.0- by 11.5-inch structural clay-tile, each with four cells 1.07 by 1.73 by 11.95 inches in dimensions, were placed with the 5.0-inch

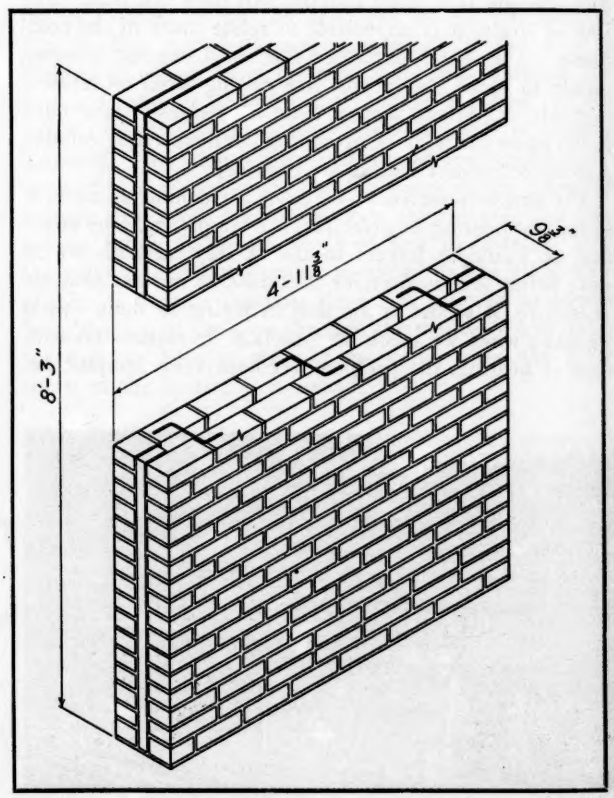


Fig. 1. Wall specimen B, tested at various rates of cavity ventilation.

dimension vertical. The edges of the cavity were sealed at the bottom, sides, and top of the wall; no finish was applied to either face. Three modifications of wall specimen C were tested, namely: C1, with the cavity completely sealed; C2, with small openings between bricks aggregating 0.9 square inch per linear foot of cavity at the top and at the bottom; and C3, with similar openings aggregating 2.5 square inches per linear foot of cavity. The openings were spaced 81 inches apart, vertically.

The results of the tests are shown in the bar chart, Fig. 2, and in Table 1. The heat-loss coefficients indicated by the bar heights in Fig. 2 are the observed thermal transmittances, expressing the number of Btu per hour flowing through 1 square foot of the warm face of the wall for 1 deg F difference of temperature of the air on the two sides of the wall. When the air was circulated gently on both sides of the wall during the tests, the average surface film conductances were approximately 2.0 Btu per (hr) (sq ft) (F) on the warm side and 1.6 on the cold side. The cross-hatched fractions of the bars for specimens B2, B3, B4, C2, and C3, in all of which ventilation occurred, indicate the estimated percentage of the heat entering the cavity from the warm side that was carried out by the ventilating air. It is estimated that the rates of ventilation in the cavity were approximately 0.4, 0.6, and 3.1 cubic feet per minute for each linear foot of cavity

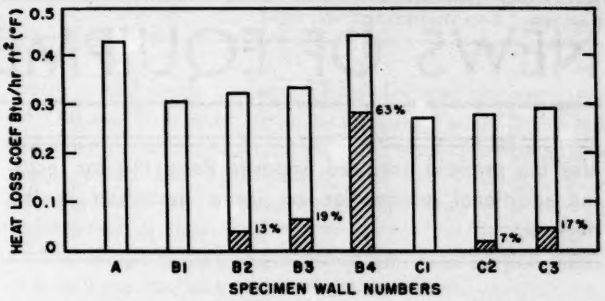


Fig. 2. Heat loss coefficients of specimen walls. Shaded areas show percent of total heat loss carried out by cavity ventilation air.

TABLE 1—HEAT LOSS COEFFICIENTS OF CAVITY WALLS

Wall type and number	Openings for cavity ventilation, sq inches per lin ft	Heat loss coefficient, Btu per (hr) (sq ft) (F)	Estimated heat carried out by ventilating air, %
Solid brick, A....	0.0	0.44	..
Brick cavity, B1...	.0	.31	0
Brick cavity, B2...	1.0	.33	13
Brick cavity, B3...	1.7	.34	19
Brick cavity, B4...	21.0	.45	63
Brick-tile cavity, C1	0.0	.27	0
Brick-tile cavity, C2	.9	.28	7
Brick-tile cavity, C3	2.5	.30	17

length for specimens B2, B3, and B4, respectively, and 0.2 and 0.6 for specimens C2 and C3.

Under the test conditions, the heat-loss coefficient of the sealed brick cavity wall was only 70% of that of the solid wall using the same amount of material. The small amounts of ventilation that took place in walls B2 and B3 increased the cavity-wall heat loss only moderately to respective values of 75 and 77% of that of the solid wall. The openings in the cold face of wall B4 were much larger than might be expected in practice, but even under these conditions the cavity wall was approximately equal to the solid wall in insulating effect. A solid counterpart of the brick-tile cavity wall was not tested, but it is estimated that for such a solid construction the heat loss coefficient would be about 0.38 Btu per (hr) (sq ft) (F). On this basis, the heat loss coefficients for the brick-tile cavity walls were approximately 73, 75, and 79% of that of the corresponding solid wall for specimens C1, C2, and C3, respectively. In practice the weep-hole openings needed to drain water from a cavity wall would probably not aggregate an area greater than 1 square inch per linear foot of cavity; consequently nearly all of the insulating effect of a sealed cavity wall of similar height may be realized under ordinary conditions.

In considering these results, it must be recognized that greater vertical height between openings into the cavity would increase the ventilation rate, although probably not seriously for cavities not more than 2 or 3 stories high.

Air Locks Protect Atomic Plant Personnel

Air locks between radioactive and safe pressurized zones are being used to protect personnel against deadly air-borne contamination in atomic plants and laboratories, it was disclosed at the March meeting of the American Society of Mechanical Engineers at the University of Washington in Seattle.

In addition to providing protective ventilation for normal processes which take place in hoods and equipment, design consideration must be given to the effects of all types of accidents such as explosions, fires, spills and other personnel errors, said W. W. McIntosh, staff engineer, General Electric Co., Richland, Wash.

In designing for directional control of air flow, he said, one method is to provide controlled differential air pressure between areas of different degrees of hazard. These areas are usually designated as zones, the uncontaminated areas being termed "cold" and the areas of greater risk termed "hot."

The zones of different hazard levels are completely separated structurally, Mr. McIntosh explained. Access between zones is through air locks. Within each zone air is supplied to areas of least risk and exhausted principally from equipment, hoods or other areas of highest risk. Ventilation balance within the zone is such that flow through doorways is always toward the more hazardous side.

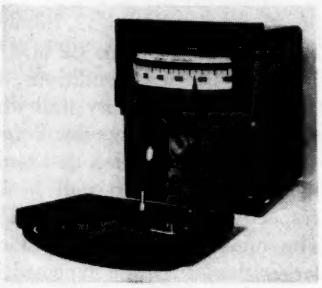
The air locks are not ventilated, but on opening the door toward the "hot" side air will leave the air lock toward the zone of lower pressure. When the air lock door to the "cold" side is opened air will flow from the higher pressure area into the air lock; thus, air movement is in the proper direction.

NEWS OF EQUIPMENT AND MATERIALS

Use the prepaid postcard opposite Page 116 for securing additional information on items described in this department.

Control for Industrial Processes

A new instrument for close control of electrically heated or fuel-fired industrial process equipment has been developed by Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.



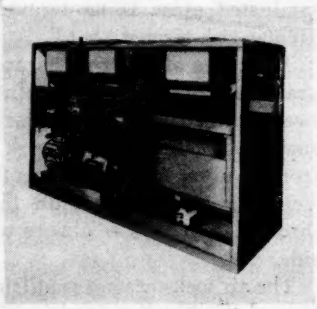
The instrument, the pulse Pyr-O-Vane controller, is a time-proportioning indicating millivoltmeter controller. Its use on such industrial equipment as small heat treating furnaces and nylon heat setting equipment will result in improved product quality and reduction of rejects. It is designed to provide straight-line control unobtainable with two-position or three-position controllers on these and other applications where rapid heating rates, small heating capacity or abnormal process lags are encountered.

The instrument has a variable proportional band between 1 and 3% of full scale. A calibrated adjustment feature facilitates changing the setting. A set of change gears supplied with each instrument provides a choice of six cycle times to meet varied process requirements. A change in cycle time is easily made.

For more information, circle on Inquiry Card, **Item 1**

Water Saving Air Conditioners

A completely new line of medium-tonnage, self-contained air conditioners, with integral evaporative condensers, is introduced by The Trane Co., La Crosse, Wis. Designed to meet the most stringent municipal regulations on water consumption and disposal, the conditioners will be produced in 15 and 20 ton capacities. This capacity range serves a broad variety of medium-sized offices, super markets, banks, restaurants, stores and other commercial and industrial applications. The units are designed to meet year-round air conditioning requirements, delivering conditioned air through a duct system.



Compressor, evaporative condenser, and air conditioner assemblies are grouped into a single, compact, space-saving cabinet. Units are shipped completely wired, piped, dehydrated, charged and tested for the operating conditions specified for each individual job. They are ready to operate with only simple electrical, water piping, and air distribution connections required.

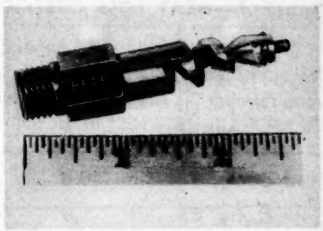
A complete evaporative condenser is built into the package system. The evaporative condenser's fan motor and pump are mounted in the conditioner-compressor section, where they are not exposed to moist conditions. Moisture condensed from the atmosphere by the conditioner's cooling coil is added to the spray water in the condenser. This helps cut over-all water consumption as much as 98% on humid days. Cooling coils and optional heating coils are standard fin and tube construction. Centrifugal fans are balanced statically and dynamically.

Complete design, specification and installation data are contained in bulletins S-362-A and D-362.

For more information, circle on Inquiry Card, **Item 2**

Stainless Fog Nozzles

A new line of low priced all-stainless steel fixed installation fog nozzles for industrial processing and fire protection has just been introduced by Bete Fog Nozzle Inc., Greenfield, Mass.



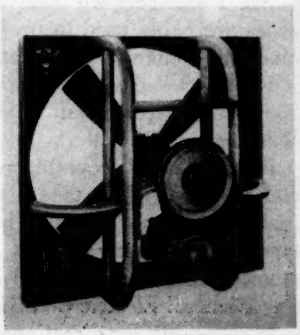
The new nozzles, known as the AA series, are smaller in size and lighter in weight than previous models. They employ a spiral principle of atomization, and incorporate many refinements in design over similar earlier models.

The nozzles are available in six models, three flow rates, 1 to 10 gpm range, and with a full or hollow cone fog pattern.

For more information, circle on Inquiry Card, **Item 3**

Belt Type Axial Flow Fan

A heavy duty belt driven fan for industrial applications and duct work where a large volume of air is required under static pressure has been introduced by Chelsea Fan & Blower Co., Inc., Plainfield, N. J. Being belt driven, the fan is quiet in operation. It is equipped with non-overloading cast aluminum airfoil type propellers.

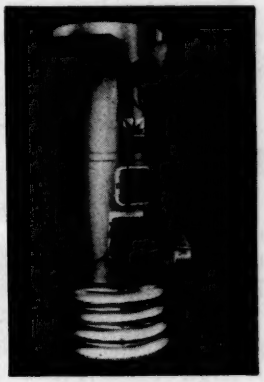


These units are completely ball bearing and motors are totally enclosed. Units are available in sizes from 24 inches to 48 inches and air deliveries from 5,000 to 28,000 cfm. Catalog 400 and Bulletin 404A are available.

For more information, circle on Inquiry Card, **Item 4**

Oil-Gas Burner for Heaters

A new combination oil-gas burner is announced by Thermobloc Div., Prat-Daniel Corp., South Norwalk, Conn. The burner is available for the complete line of the company's industrial type forced warm air direct-fired heaters.

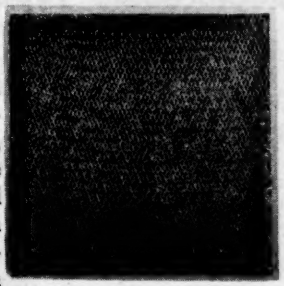


The combination burner permits instantaneous change-over from gas to oil or oil to gas. No piping or burner changes are needed. The change-over may be automatic or with manual pushbutton. The burner may be changed from gas to oil or vice versa manually, by a flick of the switch. All that is needed for completely automatic operation is an outdoor thermostat which can be adjusted to a change-over thermometer.

For more information, circle on Inquiry Card, **Item 5**

Grease Filter for Restaurants

A newly designed Airsan grease filter with extra grease holding capacity has been developed by Air Filter Corp., Milwaukee, Wis. It is specifically designed to remove entrained oil from entering exhaust ducts. This prevents fire hazards and prolongs the life of fan motors and other mechanical equipment.



The filter is constructed with full bronze welded corners and galvanized frames, electro-plated woven wire cloth medium, and expanded metal face plates. The medium is designed to provide effective filtering action and extra grease holding capacity. In addition, low air resistance is maintained for better circulation.

The filter is intended for institutions, hotels and industry, and is especially useful in galley, restaurant, or kitchen range hoods. It is also adaptable to industrial plants, particularly in heat treating departments where oil quenches are used in case hardening. Filter is available in unit assemblies for wall or ceiling types or in single or multiple units.

For more information, circle on Inquiry Card, **Item 6**

Prevents Carbon in Oil Burners

Development of an anti-carbon gasoline and fuel oil blend, effective in preventing formation of carbon in any internal combustion engine or oil burner is announced by Thrifty Products Co., Brooklyn, N. Y., distributor.

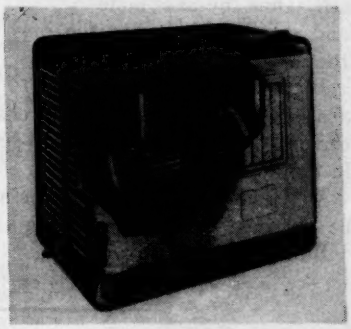
Called Ox'o-Fluid, this chemical compound, when blended at the rate of one gallon to 1000 gallons of any fuel oil, will render a cleaner and hotter flame in oil burners and keeps the tips, electrodes and strainers free of carbon. It is said to be unsurpassed with No. 6 oil for considerably reducing soot and smoke, keeping furnaces clean and in dissolving the heavy sludge, preserving tanks in a clean condition, thus resulting in substantial savings.

It is available in one-gallon containers at $5 per gallon through gas stations and fuel oil dealers.

For more information, circle on Inquiry Card, **Item 7**

Evaporative Type Room Cooler

A compact direct-drive twin-blower window evaporative type air cooler, designed to provide low-cost comfort cooling for rooms, small apartments, hotel and motel units, is introduced by International Metal Products Co., Phoenix, Ariz.



Washed air is delivered at a maximum rate of 1,000 cfm, with a variable-speed control which permits indivdiuals to control their own cooling requirements. Unit is finished in two-tone baked enamel.

An optional feature of the cooler is that it may be used as a portable, self-contained unit, requiring no outside water supply. The water reservoir in the bottom of the cooler may be manually filled through a pour-in drawer in the face panel, and a pump used to recirculate water to the filter.

For more information, circle on Inquiry Card, **Item 8**

Plastic Tube in Large Sizes

Continuous production of thermosetting plastic and Fiberglas-reinforced tubing in commercial quantities has been achieved by Reflin Co., Culver City, Calif. The resulting light weight, strong, corrosion-resistant plastic tubing gives engineers a new design material for defense applications and a substitute for presently-used materials in short supply.

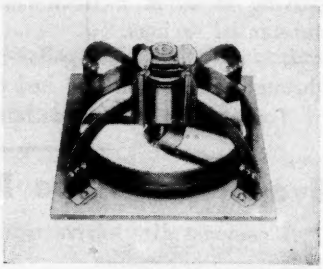
The tubing is useful for fuel-dispensing lines, standpipes, vent tubes, salt-water piping, and sanitary piping.

The tubing is available in standard sizes from 4 to 10 inches O.D., with sizes up to 36 inches available to order. Straight sections of 20 ft. in length are coupled by cemented sleeves. It is suitable for temperatures ranging from 60 to 230 deg., and is readily worked with standard machine tools and can be sawed, cut, drilled, threaded or joined.

For more information, circle on Inquiry Card, **Item 9**

Vertical Exhaust Fan

A direct drive, vertical propeller fan for exhaust use in kitchens, attics and laboratories is available from Herman Nelson Div., American Air Filter Co., Inc., Moline, Ill.



The fan, designated as model MDA, is installed flush with the ceiling, the totally enclosed motor and motor mountings being concealed by the ceiling itself. Thus the base plate and the fan blade are the only parts visible from the room.

Blade sizes range from 14 to 36 inches. Motors are available in various current characteristics. Capacities range from 1,585 cfm in the 14-inch model to 12,400 cfm in the 36-inch fan.

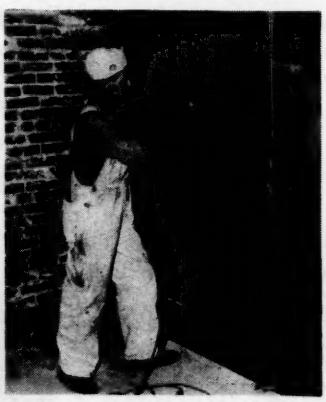
When corrosive fumes are being handled, the fan can be obtained with acid-resisting varnish.

Bulletin 3429 is available.

For more information, circle on Inquiry Card, **Item 10**

Vapor-Seal Duct Insulation

Development of Fiberglas vapor-seal duct insulation, designed to prevent condensation on air conditioning ducts which carry cool air in warm, humid areas, is announced by Owens-Corning Fiberglas Corp., Toledo Ohio. The new type material stops condensation by enclosing the duct in thermal insulation having a built-in vapor barrier of asphalt and kraft paper. Use of insulation alone has not solved condensation problems because vapor tends to pass through insulation and condense on ducts.



Use of the vapor-seal duct insulation helps lower costs because: (1) The material may be applied in a single operation, thus lowering labor costs during application. When vapor-seal insulation is used, no expensive, time-consuming separate application of a vapor barrier is necessary.

(2) The material has high efficiency and, as a result, when a certain thermal value is desired, less insulation is needed.

The vapor-seal duct insulation consists of fine fibers of glass, bonded together by a stable resin into a rigid, rectangular insulating board with clean-cut edges. One surface and both ends are covered with asphalt and kraft paper, forming an integral vapor barrier. It is furnished in 24 by 48-inch panels and in thicknesses of three-quarters, one, one-and-a-half and two inches. Vapor-seal duct insulation may be cut easily and accurately to any shape.

The material may be applied to ducts by the same conventional methods used for application of semi-rigid insulation (see photo).

For more information, circle on Inquiry Card, **Item 11**

Paper for Sheet Metal Layout

Reduction in layout time and increased accuracy on many types of sheet metal fabrication can be gained through use of Square-Up Layout Paper developed by Barrows Porcelain Enamel Co., Cincinnati, Ohio.

Originally introduced for use by sign contractors, the product is now being offered to sheet metal fabricators at large. A heavy, Kraft-type paper, it is imprinted with dotted lines indicating one-inch and six-inch squares. In addition, small dots permit measurement to quarter-inch increments.

The paper is seen as a major aid in the design and manufacture of sheet metal products where full-size paper patterns are desirable.

A 1,000-foot roll, 49 inches wide and weighing approximately 100 pounds, is priced at $21.50, f.o.b. factory. A sample measuring 8 by 10 inches is available on request.

For more information, circle on Inquiry Card, **Item 12**

Replaceable Type Air Filter

A clean, white replaceable type filter for use in all forced air heating and cooling systems is introduced by American Radiator & Standard Sanitary Corp., Pittsburgh, Pa.

An outstanding feature of this filter is its "progressive pack." The glass filaments of the filter are packed evenly across the air inlet side and then packed progressively tighter to the air exit side. With this construction, the glass filaments form a continuous web that effectively traps dirt on the inside rather than on the face of the filter.

The filter is made of continuous, slightly curled, interlaced glass filaments held in place with a thermoplastic bond. The filaments are sprayed with a special adhesive for efficiency in cleaning the air of dust and dirt particles. The filter is held in a fiberboard casing between metal grilles.

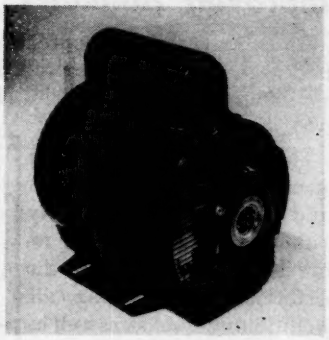
Retailers find many advantages in the filter. The white pad in its handsome package makes an attractive display item. The filter is sanitary, odorless and non-greasy. It is easy to handle and store.

The filter is available in all standard sizes; and special sizes can be obtained on request. All standard sizes of filters come packaged 12 in a carton.

For more information, circle on Inquiry Card, **Item 13**

Fractional Horsepower Motors

A new line of fractional horsepower motors embodying an entirely new concept of motor design and manufacture has been announced by the Fractional Horsepower Motor Department of General Electric Co., Schenectady, N. Y.



Designated as Form G, the new motors are the result of nearly a decade of developmental engineering and research, and incorporate many radically different and advanced design features.

The new motor weighs as much as 51% less per horsepower than the models it replaces and is considerably smaller in size. At the same time, its versatility of application has been broadened and its appearance modernized.

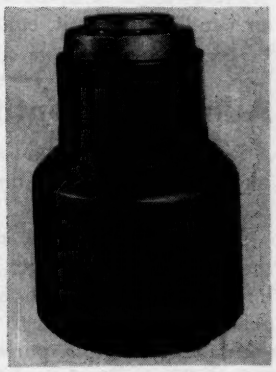
The motors are available in open dripproof and totally enclosed fan-cooled models in Types K (polyphase), KC (capacitor start), KH (split phase), and KCP (permanent split capacitor). These have hundreds of applications—on pumps, fans, blowers, compressors, office and home appliances, motorized tools of all sorts, etc. The design principles ultimately will be adapted to motors for more specialized uses as the line expands.

The advanced design incorporates a completely new insulation system developed especially for this project. It consists of a special nylon material combined with Formex wire and Glyptal varnish to give the motors longer life.

For more information, circle on Inquiry Card, **Item 14**

Low Capacity Ice Maker

An automatic ice maker, said to be the smallest commercial type ever developed, has been placed in production by York Corp., York, Pa. Known as the FlakIce automatic ice maker, Model DER-2, it is designed to produce up to 300 lb of ice in small clear fragments per day without the use of an auxiliary crusher.



The machine was designed primarily to meet the demands for equipment to produce ice in small pieces at the point of use by smaller commercial establishments including bars, soda fountains, hotels, restaurants, taverns, green groceries, chain stores, seafood houses, poultry stores and other handlers of foodstuffs, including the military, where the daily ice requirements usually do not exceed 250 to 300 pounds.

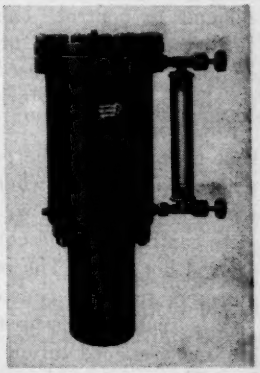
The ice is produced in a slightly curved form. Because of the greater exposed surface area, it provides faster cooling of liquids. These small fragments of ice are claimed to be so delicate that they won't bruise or puncture fish, poultry, or even roses, when used in bulk, such as in a shipping carton or crate.

The unit is air cooled and can be plugged into an electrical socket. It has a capacity range of from 200 to 300 lb daily, although the unit itself is only 32½ in. high and its widest diameter is only 24¼ in.

For more information, circle on Inquiry Card, **Item 15**

Refrigeration Purger

A forged steel purger for keeping refrigerating systems free of air without waste of refrigerant is available from Armstrong Machine Works, Three Rivers, Mich. It is available in two models, No. 370, rated at 300 lb per square inch, and No. 371 for CO_2 systems, rated at 1500 lb per square inch.



The purger separates air and other non-condensable gases from the refrigerant and discharges them to the atmosphere. Consequently, power costs are reduced by elimination of excess head pressure, time and labor are saved since the system does not have to be purged manually, there is a minimum loss of refrigerant gas while purging, and wear and tear on the motor and compressor are minimized due to reduced condenser pressure.

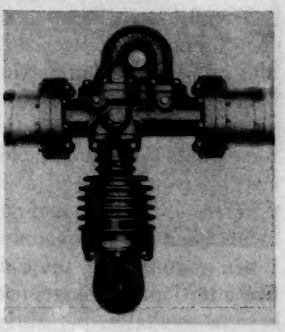
The purger is designed for large capacity installations having been made on systems from 12 to 500 tons capacity. It is suitable for all common refrigerants including ammonia, Freon, propane, and CO_2.

Bulletin 192 is available.

For more information, circle on Inquiry Card, **Item 16**

Improved Steam Meter

A redesign of its Model SMKS Shuntflo meter for steam, air or gas is announced by Builders - Providence, Inc., Providence, R. I. The following improvements have been made:

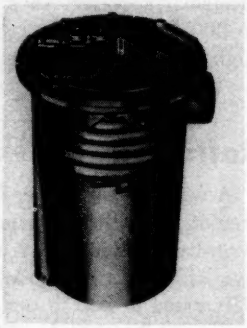


A new, streamline damping chamber is designed to facilitate a more uniform cooling system; an all-Meehanite body casting is used for greater strength and durability; there is a more simplified rotor mechanism to assure efficiency of operation, easy replacement of parts and long service, and a strengthened rotor shaft has been designed to withstand slugs of undue condensate in the line or sudden fluctuations in line pressure.

For more information, circle on Inquiry Card, **Item 17**

Economical Tankless Heater

A new feature in its tankless water heater lines, introduced by Alstrom Corp., New York, N. Y., is the built-in manual tempering valve. Already incorporated in its *T* series and Uni-Heat tankless units, this feature is claimed to effect large savings in installation cost.



Built into the removable cast-bronze convex head of the water heater, the tempering valve is easily adjusted for summer-winter control of hot water temperature and does not create a pressure unbalance which, in conventional by-pass hookups, may be noisy and difficult to control. There are further savings in time, the company states, because the valve is preset at the factory to give optimum performance under normal conditions.

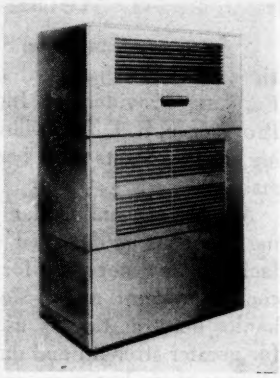
On most installations, the contractor need not waste time trying to find the proper by-pass adjustment. When a special case arises where the by-pass must be regulated, a simple twist of the wrist will give the contractor complete control over the cold water, properly tempering the desired hot water. The units are said to be precision engineered, ruggedly constructed and work-wise in design.

A ⅛-inch vent assures freedom from air bonding and uniformly spaced tubing is firmly supported and chafe-free. The units are hydrostatically triple-tested and have hot water capacities of 4, 6 and 8 gpm.

For more information, circle on Inquiry Card, **Item 18**

Side or Top Mount Conditioner

A new Unitaire air-conditioner, MU-101, is available from Air Conditioning Div., Westinghouse Electric Corp., Boston, Mass. This 10 hp, self-contained unit is intended for conditioning offices, markets, stores, manufacturing areas, or other applications that call for dependable, economical air conditioning.



Two 12-inch, double inlet fans nominally deliver 4000 cfm of air. The fan section, which can be mounted either on top of the cooling section (see photo) or at the side, can be rotated to give six different discharge arrangements when it is top-mounted. When mounted at the side, five additional arrangements become available, permitting adaptation of this unit to any type installation.

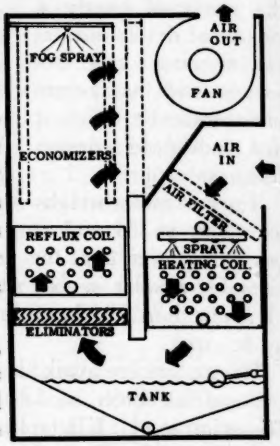
The gray cabinet, which is thermal and sound insulated with glass fiber and aluminum foil, is 91 inches high when top-mounted, and 61 by 32 inches at the base, so that it fits into recesses to save floor space. In its side-mounted arrangement it is 63 inches high.

Adaptability is provided by accessory heating coils, and unit control is provided by a control board with a selector switch and thermostat adjusting knobs.

For mroe information, circle on Inquiry Card, **Item 19**

Improved Humidity Control

An improved model concentrator for the drying agent used in the company's controlled humidity method of air conditioning is announced by Niagara Blower Co., New York, N. Y.



This method uses a drying agent to absorb moisture from air directly, reducing humidity without refrigeration therefore it is applied to increase the performance of exising air conditioning systems as well as to processes and industries where materials are dried or protected from atmospheric moisture.

The drying agent is a liquid, Hygrol, which has hygroscopic properties that afford control of the relative humidity of the area or process that is conditioned. As it is diluted by the moisture it absorbs, a part of the liquid is pumped to the concentrator. In the concentrator this moisture is continuously removed so that the air conditioning is always operating at full capacity.

In the new model the diluted liquid is sprayed into an air stream over heating surface which raises its temperature, evaporating the water. The air stream then passes through eliminator plates which remove the liquid drops. Then, in a second stage, it passes over a cooled reflux coil which raises the relative humidity in the chamber, condensing the absorbent vapor. In the third stage, it passes through filtration cylinders each of which contains a fog nozzle. Here the building up of very high humidity completes the condensation of the absorbent liquid and its droplets are caught by the filters while the moisture laden air passes through. The re-concentrated absorbent drains to the tank in the base from which it returns to the air conditioning unit, completing the cycle.

For more information, circle on Inquiry Card, **Item 20**

Adhesive Identification Decals

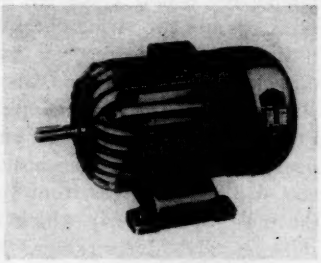
Production of Metal-Cals, a permanent, self-adhesive identification device, is under way by C & H Supply Co., Seattle, Wash.

Consisting of a 0.003 inch thickness of aluminum foil, the device is backed with a high-tensile strength bonding material. It requires no rivets or other fastening devices and is quickly applied to any smooth, cohesive surfaces such as metal, glass, porcelain, wood, paint and enamel. The foil, anodized and dyed, provides a permanent method of applying trade names, diagrams, operating and maintenance instructions, dial and gage markings, insignia, trade marks and dealer trade names.

For more information, circle on Inquiry Card, **Item 21**

Fan Cooled Motors 1/4 to 3 Hp.

A new series of totally enclosed fan-cooled motors ranging from ¼ through 3 hp., is introduced by The Hoover Co., Kingston-Conley Div., North Plainfield, N. J. Compact design has been stressed on all models in this new line, resulting in more horsepower per pound of motor.



The motors are easy to clean and keep clean. All blind passages that might possibly accumulate dirt have been eliminated on both fan-cooled models. Whenever, and if ever necessary, the fan shroud can readily be removed, exposing the entire cooling system without disassembling the motor and without removing it from the application.

For more information, circle on Inquiry Card, **Item 22**

Hot Water Boosters

A new line of booster pumps designed to meet the need for more compact, space-saving units in hot water heating systems is introduced by Bell & Gossett Co., Morton Grove, Ill.

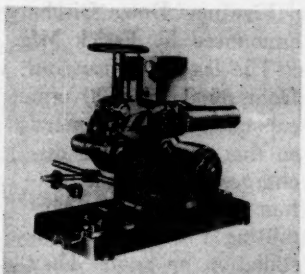
Despite their reduced size, the new lighter units deliver more gallons per minute at a lower cost in electric power than their predecessors. In addition, they conserve critical materials.

The three new boosters comprising the new line are each powered by a small one-twelfth horsepower motor and are identified by the numbers 75, 100 and 125. These compact pumps are in step with the trend to smaller homes in which operating equipment as small as possible is desired.

For more information, circle on Inquiry Card, **Item 23**

Pipe and Tube Cut-Off Machine

Cutting pipe and tubing up to 12 inches in diameter can be accomplished automatically by a machine which cuts as many as 60 pieces of 12 inch pipe and tube per hour, and cuts smaller sizes proportionately faster. It is a product of Continental Machine Co., Chicago, Ill.



The machine operator feeds the pipe to the adjustable set stop, steps on a foot switch and the air cylinder, precision electrical controls and air mechanism accurately gage the speed at which the blade approaches pipe. When foot switch is actuated, the pipe starts spinning slowly as the blade engages it, then heavy cutting pressure is exerted. It automatically retracts the blade after each cut.

For more information, circle on Inquiry Card, **Item 24**

Plastic Pipe for Water Service

The type WS plastic pipe, developed primarily for water service installations and applications involving high vacuum, is announced by Carlon Products Corp., Cleveland, Ohio. Similar to the company's type EF flexible pipe, this new type has increased wall thickness for protection against burst or collapse when handling higher working pressures or operating in a suction line.

The pipe features flexibility, light weight and resistance to rot, rust and electrolytic corrosion. Its smooth internal surface will not accumulate scale or sediment. It is recommended for water service connections, use in sand and gravel pits, general construction applications, natural gas transmission, and similar applications.

Rapid, low-cost installation is possible with this pipe because of its light weight, flexibility and ease of connection. No special tools or rigging equipment are required. It can be curved to follow irregular contours or to conform to structural plans, and it is furnished in long lengths which require fewer fittings. Plastic-to-plastic or plastic-to-metal connections can be made quickly by means of molded plastic fittings. It is available in nine sizes ranging from ¾ to 6 inches nominal pipe size. The smallest diameter is supplied in 400-foot coils and weighs only 0.216-pound per foot.

For more information, circle on Inquiry Card, **Item 25**

Commercial Garbage Disposer

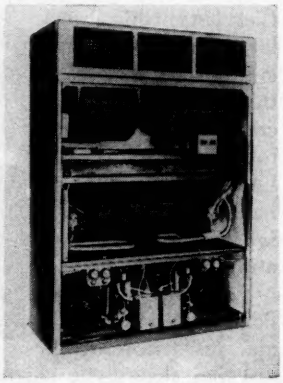
Garb-El, an automatic garbage disposer which processes 12 to 15 bushels of produce waste or 120 gallons of food waste per hour, is being distributed nationally by Garb-El Products Corp., Buffalo, N. Y. The unit is quiet in operation and compactly designed. It reduces the costs of garbage handling, saves labor, time and space, and ends unsightly and insanitary accumulation. It is designed for commercial and institutional kitchens and for packers and super markets.

The machine, controlled by a single lever, automatically feeds waste into a 1500 rpm hammermill where, mixed with water, the waste is pulverized and discharged directly into the sewer. Safety devices protect both operator and machine. The unit is 32 inches high, 42 inches long and 20 inches deep.

For more information, circle on Inquiry Card, **Item 26**

Conditioner Has Two Circuits

A 10-ton upright self-contained air conditioner, suitable for store, office, residential and other uses, and featuring two complete separate refrigeration circuits, has been added to the line of United States Air Conditioning Corp., Minneapolis, Minn. The dual circuit provides economy of operation when the full cooling capacity of the unit is not required and enables the equipment to meet the usual local code requirements.



The new conditioners contain a number of other features including a manual bypass damper in the blower section, which permits increased dehumidification without excessive cooling semihermetic compressor sections to minimize space requirements and maintenance problems; pressure relief valves on condenser-receivers; charging valve on liquid line to facilitate charging of the unit; and separate magnetic starter for fan motor, providing full overload protection.

Both 5-ton circuits are set up on pump-down cycle, eliminating slugging of compressors at start-up. Line solenoid valves and low pressure control are utilized to provide satisfactory operation of the cycle.

For more information, circle on Inquiry Card, **Item 27**

Industrial Feedwater Heaters

Feedwater systems for industrial boilers which can be purchased as complete systems or in four separate kits for specific jobs are being manufactured by Industrial Div., York-Shipley, Inc., York, Pa., under the York-Power trademark.

The complete feedwater system is made up of four kits. The kits are the makeup assembly, heater assembly; receiver assembly, and complete pump assembly. Each kit can be purchased separately. The systems are manufactured for use with the maker's steam generators and are so designed that they will handle any type of condensate return problem. They are compact, flexible units that automatically supply hot make-up water for boiler operation, and will operate with a high degree of efficiency with any type of steam boiler. The system reclaims both high and low pressure condensate and maintains a constant uniform water temperature which effects substantial fuel savings by eliminating the waste of using cold make-up water.

By supplying the boiler with pre-heated condensate water, which is practically distilled water, the life of the boiler will be prolonged and maintenance costs will be substantially reduced. In addition to the fuel savings, effected by supplying hot make-up water, stresses set up by applying cold water to hot surfaces are eliminated.

The system is economical to operate, high in efficiency, and low in cost, making it indispensable wherever power or heating applications of steam are used.

Pump set assemblies are available for 100, 125, and 150-pound per square inch pressure and for boilers from 15 to 300 hp. Higher pressures can be furnished on order. The assembly consists of motor, turbine pump, base plate, connecting coupling, starter, thermometer, pressure gage, strainer, and two swing check valves.

Capacity of the receiver assembly ranges from 30 to 450 gallons. Assembly consists of receiver tank, gage glass, steam diffuser, and baffle plate. Heater assemblies are available in eight sizes ranging from ½ to 2-inch capacity. Assembly includes heater, aquastat solenoid valve, and strainer. Six sizes from ½ to 2-inch are available in the make-up assembly which includes tank float switch, solenoid valve, and strainer.

For more information, circle on Inquiry Card, **Item 28**

Testing for Cracks, Flaws

A process for detecting cracks, pores and cold shuts in all types of metal parts which cannot be seen by the inspector has been introduced by Met-L-Chek Co., Hawthorne, Calif. Advantages include use for nonferrous parts which cannot be tested by magnetic testing processes and testing in the field which cannot be done by fluorescent testing processes.

The process is a penetrant dye process which requires only two solutions, the dye and developer. Parts are swabbed with the dye which is washed away with water and the part then swabbed with developer. The developer pulls the dye out of the cracks, showing a vivid red stain wider than the flaw at the fault. Illustration shows crack in weld being shown up by developer.

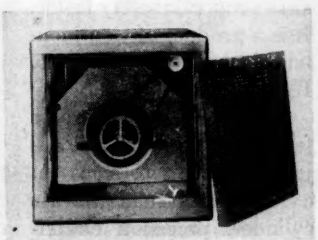
Field test kit which covers 60 square feet is priced at $4.95.

For more information, circle on Inquiry Card, **Item 29**

Downdraft Evaporative Coolers

Five new Down Discharge evaporative air coolers are announced by Essick Mfg. Co., Los Angeles, Calif.

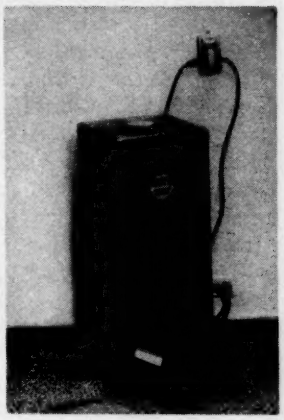
The coolers, ranging from 3700 to 6600 cfm capacity, are constructed so that the cool air discharges through the bottom of the coolers, permitting a more simple installation on roofs. They may be installed without exterior ductwork, which is sometimes unsightly, thereby eliminating at least one elbow and one joint of duct in all installations. Besides improved appearance, the shorter run of duct used for installation is of importance.



For more information, circle on Inquiry Card, **Item 30**

Industrial Type Dehumidifier

The Model WA-5 industrial dehumidifier is now available from Abbeon Supply Co., Jamaica, N. Y. It is intended for continuous or intermittent operation without automatic control, it can be supplied with an optional plug-in control so that all that is necessary for automatic operation is to plug the unit into the control, plug the control into the nearest electric outlet, and set the dial of the control at the percentage of humidity desired. This humidistat then acts like the thermostat on a heating system and turns the unit off and on without further attention when the desired level of humidity is reached. This unit is illustrated.

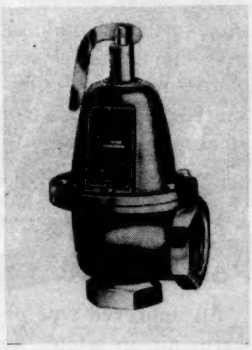


The unit is also available with the control built into the front of the unit as a permanent part of the unit, and in this case it is just necessary to plug the unit itself into the wall socket and set the control for automatic operation.

For more information, circle on Inquiry Card, **Item 31**

Hot Water Relief Valve

The Type F-51, a safety relief valve for hot water space heating boilers, tanks and heaters has been introduced by A. W. Cash Valve Mfg. Corp., Decatur, Ill. It is available in pressure settings from 30 to 125 lb with correspondent Btu ratings at various pressure settings



The valve has sufficient capacity to relieve pressure due both to the thermal expansion of water as well as steam which is generated by failure of the firing device to shut off. It is an all bronze valve, incorporating an exceptionally high lift design, stainless steel spring and silicone seat disc. The valve is priced competitively.

The valve is approved by the National Board of Pressure Vessel Inspectors and meets A.S.M.E. requirements.

For more information, circle on Inquiry Card, **Item 32**

Acid Resistant Plastic Pipe

Tubing and piping made from rigid unplasticized Geon 404 polyvinyl chloride is now being manufactured by Van Dorn Iron Works Co., Cleveland, Ohio.

Capable of being sawed, drilled, threaded, and welded, materials made from Geon 404, a product of B. F. Goodrich Chemical Company, are used in the chemical field where extreme resistance to corrosion is required. Unplasticized polyvinyl chloride's chemical resistance to organic and inorganic acids, foodstuffs, alcohol, and alkalies plus its ease of fabrication make it useful in applications such as valves, pipe fittings, hoods, tanks, fume systems, acid drain systems, and vats.

In tests it was found that over 2,000 lb per sq in is needed to burst 1-1/4-inch pipe.

The pipe comes in 1/2 to 2 inch stock and the walls are 1/4 inch thick. This piping can be threaded on standard pipe dies and may be equipped with acid resisting plastic tees, 90° elbows, 45° elbows, companion flanges, blind flanges, couplings, reducing couplings, and caps.

For more information, circle on Inquiry Card, **Item 33**

New Line Stop, Waste Valves

A complete new valve line in both iron pipe and copper to copper stops and stop and waste patterns is now being produced by Glauber Brass Inc., Kinsman, Ohio.

Identified as the 900 series, this new design is streamlined for lighter weight without sacrificing quality standards of operating specifications. Full waterways are used throughout and a tapered seat gives greater bearing surface insuring positive shut-off and long trouble-free service life.

Sizes from ½ inch through 1 inch are available in all patterns.

For more information, circle on Inquiry Card, **Item 34**

Threaded Rod Makes Bolts

A threaded steel rod for industrial repair, installation, and construction work, has been put on the market by Redi-Bolt, Chicago, Ill. It is designed to save time and money on jobs requiring long bolts or rods, or bolts of special shape.

The rod comes in straight 36 in. lengths and in six diameters — ¼, 5/16, ⅜, ½, ⅝, and ¾ in., precision-threaded the full length. It is made of cold-drawn steel. A coating protects the rod against rust.

Long straight bolts and adjusting rods can be made in seconds by simply hack-sawing the rods to size, and fitting with standard nuts. Or, after heating the rod with a blowtorch, it can be bent into U-bolts, L-bolts, eye-bolts, or any one of a dozen other shapes. No threading is necessary. The part is ready for immediate installation. Photo shows mechanic forming an eye-bolt from Redi-Bolt.

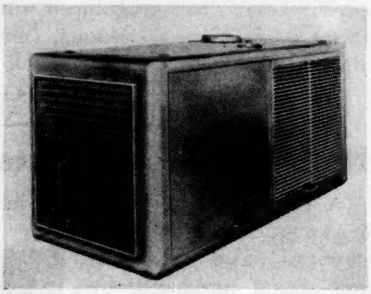
Applications include hangers for overhead equipment, steam and water pipes, power packs, unit heaters, and conveyor systems. It also can be used to mount ducts of all kinds.

For more information, circle on Inquiry Card, **Item 35**

Gas Central or Unit Heater

An all-purpose, gas unit heater, the Pac, has been introduced by Reznor Mfg. Co., Mercer, Pa.

The 100,000 Btu per hour model measures 22 x 23 x 47½ inches. All controls are enclosed within the trim, modern case. It operates with natural, manufactured, mixed and LP gases.



It has been approved by AGA as a central heating gas appliance for use with or without ducts, and as a unit heater for use with or without ducts. Thus the one unit can be specified as a unit heater for a business establishment or installed with a duct system in a home for central heating.

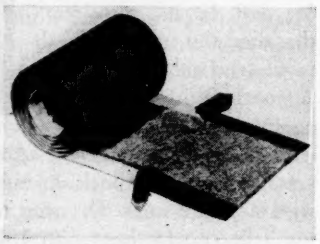
Flanges on both ends can be fitted with the company's standard louver panels or used to connect ducts. Four tapped sockets are provided on both top and bottom for either suspended or base mounting. The flue can be used from top or side by simply switching casing and connector plates.

As a central heater the unit affords special advantages because size and appearance permit a wider choice of installation locations. As an example, the size and finished appearance permits exposed installation in the kitchen if desired. Since the unit can be mounted near the ceiling with ducts running above wall cabinets, it can contribute to savings in building costs. The compact unit will fit into top areas of closets and allow ample room for normal use. It suits attic, basement, utility room, garage or other installation preferences. In larger homes use of more than one unit provides zone control and shorter runs of ducts.

For more information, circle on Inquiry Card, **Item 36**

Self-Stick Pipe Insulation

An easily applied, self-sticking pipe insulation has been developed by Mystik Adhesive Products, Chicago, Ill. It is said to cut time and labor costs on the installation of pipe insulation.



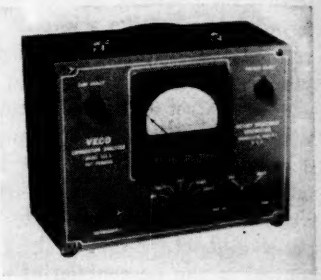
The product, designated Mystik Dri-Pipe, has a waterproof, vapor-barrier backing lined with a thick blanket of insulation. The edges are coated with an adhesive for installing the insulation on the pipe. No tools or strapping are necessary.

Especially useful for low-temperature application, the insulation prevents condensation and dripping. Icing and frosting are eliminated when applied on refrigeration lines. It is also used for warm water lines, warm air ducts and for sound deadening.

For more information, circle on Inquiry Card, **Item 37**

Combustion Analyzer

The Model 140-A Veco complete combustion tester, which combines the accuracy of a laboratory Orsat-type tester with ease of operation that all-electric operation alone can achieve, is announced by Victory Engrg. Corp., Union, N. J. All three important factors in furnace operation — CO_2 content of flue gas, temperature of flue gas, draft over fire—are measured by this two-probe instrument.



Features include: glass coated electronic thermistor; gas analysis cell, with built-in temperature compensator; filter-drier requiring only 6 to 8 squeezes of hand aspirator; vibration and shockproof; clean, easy operation.

One probe is inserted into a small hole in flue to measure CO_2 content and stack temperature, other is inserted in front of furnace to measure draft over fire, permitting a series of readings to be taken without moving probes.

For more information, circle on Inquiry Card, **Item 38**

Insulation Is Strengthened

The H or heavy-duty line of Infra multiple accordion aluminum insulation made by Infra Insulation, Inc., New York, N. Y., is being strengthened through the conversion of the peak aluminum sheet to 0.002 inch thickness and the flat sheet to .001 inch thickness. On the line for 16 inch centers, the conversion is already in effect; on the 24 inch line conversion will take place as existing stocks are replaced.

For more information, circle on Inquiry Card, **Item 39**

Portable Warm Air Furnace

An improved type of portable furnace which furnishes warm air in winter and circulates air in summer, is announced by Fageol Heat Machine Co., Detroit, Mich.

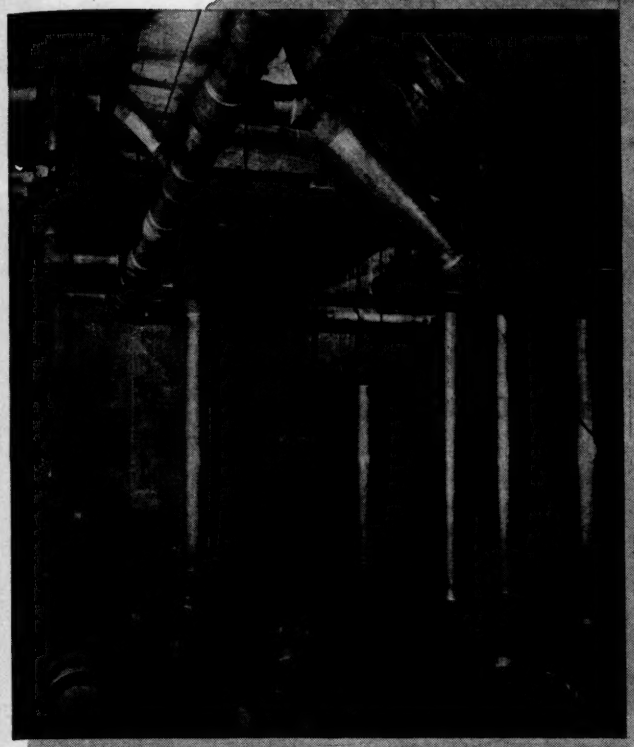
Known as Dual Purpose Model 189, the unit delivers 189,000 Btu. Warm air is distributed at floor level over an area approximately 3,000 square feet.

The furnace is so designed as to be easily converted to a blower in summer. By changing the top blower mounting, said to be a 5-minute task, the machine circulates 1500 cfm of air. These units are manufactured and sold on the West Coast by an affiliated company, Chimney Furnace-Western, Seattle 44, Washington.

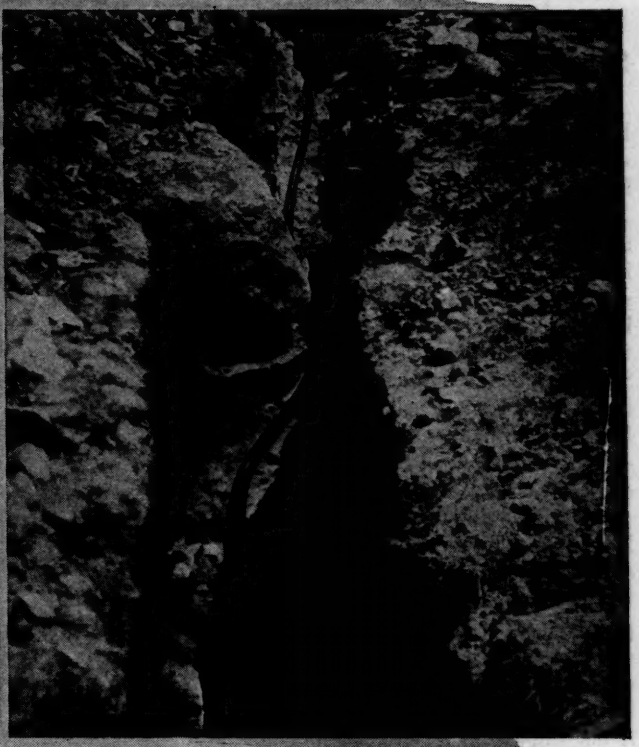
For more information, circle on Inquiry Card, **Item 40**

(Continued on page 114)

Now, it makes more sense than ever to use...



ONE VITAL SPOT where Revere Copper Tube can be used is in the conveying of liquids in industrial processing. Here is just the place for Revere Copper Tube to show its true worth. For it is non-rusting and will resist the corrosive action encountered in many of the process applications.



UNDERGROUND Revere Copper Water Tube resists the corrosive action of water inside and that of the soil on the outside. It can be bent around obstructions; made to follow the contours of the ground. Its long sections, which may be had in coils, are easier to handle, require fewer fittings.

COPPER WHERE IT COUNTS!

USING Revere Copper in the vital spots has always made common sense. Now, with copper restricted for some uses and limited for others, it becomes even more important to use "Copper Where It Counts!"

Three of these places are: industrial process lines, underground service lines and for domestic hot and cold water lines. Revere Copper Water Tube can be used for these purposes. So, whether you are a contractor, engineer or builder it will pay you to specify and use what copper you *can* get where it will do you and your customers the most good. That means in the spots where rustable materials can't stand the gaff.

Revere Copper Tube is non-rusting, has high corrosion resistance, is easily worked, installation costs are no more than for short-lived materials. It is joined with solder or compression fittings. Revere Copper Tube is ideal for replacement as it is readily bent, requires fewer fittings. It is available in hard and soft tempers, in straight lengths; also in 60′ coils in soft temper. Each length is marked with the name Revere. Look for this mark. It assures uniform quality.

To maintain your reputation for top-quality jobs, while metals remain short, use Revere Copper Water Tube wherever you can. The Revere Technical Advisory Service will be glad to help you in every way possible. Avail yourself of this service through your Revere Distributor. Call him today.

REVERE

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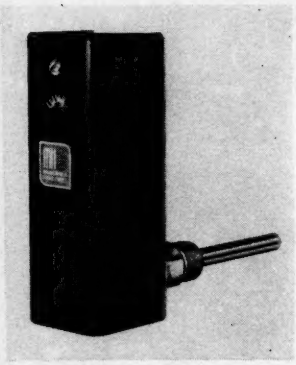
(*Continued from page* 112)

Six Fast Acting Aquastats

Six new aquastats to meet the demand for hot water boiler controls that are fast-acting and easy to install, are announced by Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.



The new models, called the L4006 series, feature an improved liquid expansion sensing element that rapidly detects and responds to temperature changes. Switching is accomplished by a completely enclosed Micro pin-plunger snap switch. The control point can easily be set externally without removing the cover. No lubrication or special care is necessary.

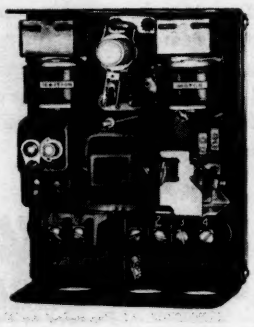
The new line makes easier and less costly installation possible, especially on small boilers where pipes and other obstructions are invariably in the way. They also are easier to service. On the well type, the device can be installed from the front. This erases the inconvenience, if not impossibility, of reaching tools around insulation and piping. The aquastats without a well, or the direct immersion type used for speediest action, are just as easy to install since there is no need to swing the whole control to make the connection.

The aquastats are mounted with the element inserted horizontally into a boiler, tank or other vessel. Models are available to break or make contact on temperature rise or with SPDT action.

For more information, circle on Inquiry Card, **Item 41**

Improved Oil Burner Control

An improved design of its intermittent ignition type primary oil burner control has been introduced by White-Rodgers Electric Co., St. Louis, Mo. It has an independently timed scavenger period of approximately one minute each time the burner stops, protecting the installation in the event of power interruption, flame failure and excessive voltage drops, as combustion chamber has time to purge and ignition cannot be re-established until completion of scavenger period. This timing is predetermined within the control and is not dependent on the stack temperature.



The control automatically recycles on flame failure. This automatic restart prevents useless lockouts, eliminating the necessity of manual restarting, thereby reducing customer complaints. If flame failure persists, control goes on automatic safety lockout.

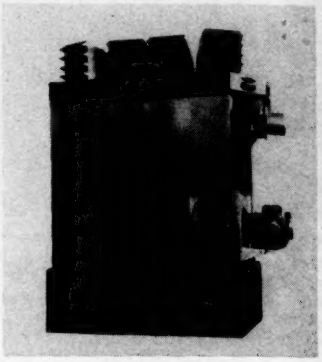
Other features include safety shut down on ignition failure, by which the control automatically locks out after approximately 1½ minutes. Manual restart button must then be pressed to put system back into operation. Control has adjustable ignition timing which assures satisfactory ignition timing adaptable to a wide variety of individual installations. The positive ignition period is adjustable from 45 to 90 seconds after flame is established. This period is determined by timing within the control and not affected by installation variations or stack temperature.

The control is also available in a constant ignition model.

For more information, circle on Inquiry Card, **Item 42**

Large Oil or Gas Heater

A new model Thermobloc capable of producing 2 million Btu per hour output has just been announced by the Thermobloc Div., The Prat-Daniel Corp., South Norwalk, Conn. The new model, designed for large industrial applications, will heat an area of from 16,000 to 24,000 square feet.



The new model has twin heat exchangers arranged in the form of a V. This results in maximum scrubbing of the heating surfaces by the air passing through. For discharge, diffusers give accurate control of air throw, and may be placed in any position desired. Single ducts may be run from any outlet to adjoining rooms if heat is needed in these places.

Normal air output is 22,000 cfm, and the air intake velocity is 440 feet per minute. The fan is powered by a 10 hp motor. Unit can use either light fuel oil, with a pressure atomizing gun-type burner; heavy oil, using a horizontal rotary cup burner; or gas, using a power burner. It may also be equipped with a combination burner for instantaneous conversion of gas to oil or oil to gas.

For more information, circle on Inquiry Card, **Item 43**

Coating Protects Steel Sheets

A hard and durable coating for protecting steel sheets against corrosion and excessive heat is announced by Mid-America Steel Warehouse, Inc., Chicago, Ill.

Called Leafcote, the coating carries phosphatizing and painting a step further. After both sides of either a cold or hot rolled steel sheet have been degreased, pickled and phosphatized, they are heated after which the coating is bonded and baked on for toughness and lasting adhesion.

This new coating can be used as a prime coating or it can be finished in any color desired.

For more information, circle on Inquiry Card, **Item 44**

(*Continued on page* 116)

Grandpa Never Threw a Thing Away

It's only human to want to hold on to things after they've outlived their usefulness. That's why today millions of tons of worn-out and obsolete equipment and machinery are lying forgotten in the country's plants and factories and on farms.

The steel industry needs these millions of tons of dormant scrap, needs it in the worst way. With this vital dormant scrap the entire steel supply picture would brighten up, with more steel for everybody. But without it, the steel industry cannot hope to keep up production at present levels.

Call in a scrap dealer now, today. He will buy your dormant scrap and start it moving toward the steel mills.

BETHLEHEM STEEL

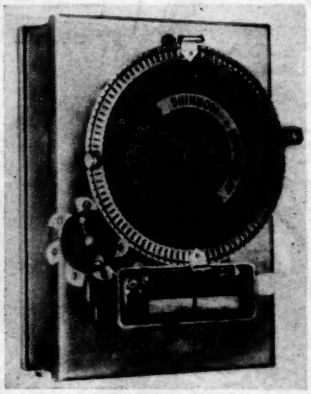
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

More Scrap Today... More Steel Tomorrow

(*Concluded from page* 114)

Room Cooler Time Switch

The Time 'Trol, a portable, plug-in, automatic timer switch for air conditioners up to and including ¾ hp capacity, is introduced by Time 'Trol Co., New York, N. Y. The timer is by Tork and the motor by Telechron.



The control has a 24 hour dial, six hours for morning, 6 for afternoon, 6 for evening, and 6 hours for night. It has two sets of *on* arms and two sets of *off* arms allowing for two settings daily, *on-off*, and *on-off*. The control will automatically turn any room air conditioner *on* and *off* at any desired time.

Model 9152W has an omit wheel, which allows the setting of air conditioners to remain *off* any day or combination of days desired. The control will automatically turn the air conditioner *on* again at the time it is set for, on the day when operation is desired. Unless the setting is changed, it will continue to operate each week on set schedule.

No installation is required. The control is completely portable and automatic, simply plug-in.

For more information, circle on Inquiry Card, **Item 45**

0.6 G. P. H. Domestic Oil Burner

Exhibited for the first time at the 29th Oil Heat Exposition in Philadelphia was the Nairoil Model J, Size 0 domestic oil burner made by National Airoil Burner Co., Philadelphia, Pa. The outstanding feature of this burner is its capacity range, which is low as 0.6 gallon per hour.

Incorporated into the design is a new type of air adjustment band, which is said to allow more accurate and positive control of air for combustion. Removal of the rear cover allows the service man plenty of room to work on wiring and oil tube. Near perfect alignment of all parts, plus the use of a flexible coupling between motor and pump, assure silent operation and long life.

For more information, circle on Inquiry Card, **Item 46**

7/32 In. Heat Absorbing Glass

The functional characteristics of Solex, heat-absorbing, glare-reducing plate glass, have been successfully imparted to a flat drawn sheet glass, it is announced by Pittsburgh Plate Glass Co., Pittsburgh, Pa.

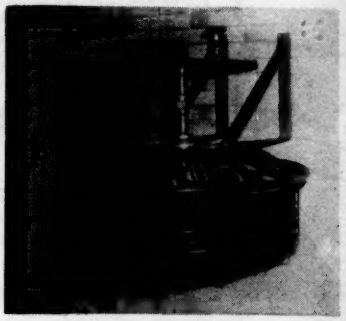
To be known as Pennvernon Solex, the new greenish tint heavy flat drawn glass product possesses approximately the same heat and glare-reducing properties as the ¼ inch Solex plate glass product. It is immediately available in cut sizes not to exceed 15 square feet in one thickness, 7/32 inch.

Manufactured especially to reduce the intensity of solar radiation, the glass actually takes the heat out of sunshine without sacrificing the light transmission characteristics of high quality glass. In some instances, it acteristics of high quality glass.

For more information, circle on Inquiry Card, **Item 47**

Simple Hose Reel for Industry

A new type industrial hose reel is introduced by Zierden Co., Milwaukee, Wis. This unit can be mounted out-of-the-way any place hose is needed, making it unnecessary to coil hose on the floor, hang it on a nearby post or loop it on wall hooks. The hose can be unreeled eight times faster than it is possible to move it from any of the above mentioned places.



Hose required to reach the point where needed is merely pulled from the free rotating reel. As the hose is fed out, there is no kinking, crimping, or tangling. To replace the hose when not in use, it is simply pushed back on the reel where it is automatically coiled for instant re-use.

To meet the broad range of industrial plant needs in handling hose, five different reel mountings are available. They are: (1) through-the-wall; (2) through-the-floor; (3) regular; (4) island; (5) over-head.

With (1) the reel is placed behind partition or building walls and held in place with heavy angular braces bolted to the wall. Hose is quickly unreeled through a stainless steel outlet box mounted flush with the wall. With (2), the complete reel assembly is mounted beneath the floor where pipe connections are made to the reel spindle. The hose is attached to this latter unit. A suitable hole is made in the floor which corresponds to the opening in the outlet assembly. Hose is reeled in or out through this opening. With (3), as shown in the photo, the reel assembly is mounted on any wall surface convenient to the piping outlet and the hose need. Island mounting is for hose that must be centrally located for general use in a specific area is efficiently handled on an island mounted reel, while the overhead mounted reel is to conserve valuable floor space. The complete assembly is placed well above head level.

For more information, circle on Inquiry Card, **Item 48**

Very Low Pressure Recorder

The ultra-low pressure recorder described on these pages in last month's issue incorrectly appeared under a heading "Very Low Temperature Recorder." The instrument for recording very low pressures is made by the Dickson Company, Chicago, Ill.

PRODUCT INFORMATION SERVICE

Use the postage-free postcard below for further information on:

- **News of Equipment and Materials**
- **New Catalogs**

Circle the Item Numbers in which you are interested and print clearly your name and address with title.

NEW CATALOGS

BOOSTER FOR HOT WATER

A four-page folder describing its electric hot-water boosters used in connection with commercial dishwashing equipment, has been issued by Waage Electric, Inc., Kenilworth, N. J. These heaters are mounted near the dishwasher and boost the temperature of the hot water supply to meet sanitation and perform-section on engineering data....**Item 49**

GAGE GLASSES AND ACCESSORIES

An 8-page folder, Bulletin 11-1-51, has been issued by Ernst Water Column & Gage Co., Livingston, N. J. and describing its gages, gage glasses, gage glass inserts, and flow indicators for insertion in pipe lines.....**Item 50**

AIR CONDITIONING PUMPS

Form 7177, a picture-type bulletin which illustrates the various types of Motorpumps and their uses in the air conditioning field, is issued by Ingersoll-Rand Co., New York, N. Y. Included are a number of installations such as cooling towers, evaporative cooler and condenser water handling. Sectional views, with complete descriptions of the various pump parts, point-up the construction features of the Motorpumps.....**Item 51**

BOOKLET ON STEAM GENERATORS

Just released by Clayton Mfg. Co., El Monte, Calif., is a new booklet No. C10 on its automatic, self-contained steam generator. Details are given on specific industrial applications, use of single and multiple installations is described, and efficiency in steam generation made possible by the forced recirculation principle is demonstrated graphically by charts and cutaway drawings. Operational data are included.....**Item 52**

AIR CONDITIONING SMOKE ALARM

Bulletin AC-2 of Ess Instrument Co., Bergenfield, N. J., describes its electric eye unit guarding against smoke circulated by air conditioning system causing panic hazard or merchandise damage. Smoke may enter system from an outside source, recirculated from fire in other parts of system, or from spontaneous combustion in filters. Unit will give alarm or shut down circulating fans...**Item 53**

SERVICE MANUAL

A 28-page service manual has been published by McDonnell & Miller, Inc., Chicago, Ill., to cover the company's line of boiler water feeders, low water fuel cut-offs, safety relief valves and related products. This new manual has general servicing information plus specific instructions for individual products. Cross section illustrations are employed throughout to identify the replacement parts available. Manual includes a product index for quick reference to the information and parts that apply.....**Item 54**

STEEL FIN CONVECTORS

Useful information on design, ratings, installation and performance of Fintube convectors is presented in Catalog 587 available from The National Radiator Co., Johnstown, Pa. These convectors contain heating elements of steel fins on steel pipe, and can be incorporated into commercial, industrial and institutional heating systems employing hot water or steam at low or high pressure.....**Item 55**

GUIDE TO PUMP APPLICATIONS

A new type of reference chart on small pump applications has been developed by Tuthill Pump Co., Chicago, Ill. In one convenient table, this guide lists the various types of the company's pumps, services for which each is built, performance characteristics, types of packing, styles of mounting, and features that distinguish each model.....**Item 56**

FIRE FIGHTING EQUIPMENT

A 6-page bulletin entitled Fire Fighting Equipment for Industry has been published by Wirt & Knox Mfg. Co., Philadelphia, Pa., and covering its hose racks, hose carts, reels, fire line valves, and cabinet outfits.....**Item 57**

COOLING TOWERS

A 4-page bulletin, No. 5.9.083, covering its Cotospray cooling towers, has been issued by J. F. Pritchard & Co., Kansas City, Mo. Folder, profusely illustrated, shows the constructional and operating features of the cooling towers, and includes capacity and dimensional data as well as information on selection. **Item 58**

ODOR REMOVAL CABINETS

A data sheet, Form 131-252, on its activated carbon odor removal units has been issued by Pur Air, a division of American Solvent Recovery Corp., Columbus, Ohio. Sheet describes the Model A-5 for spaces up to 4,500 cubic feet and the Model A-10 for spaces up to10,000 cubic feet.....**Item 59**

ALL-PURPOSE CENTRIFUGAL PUMP

A specification folder, Form S-100, describing its Model P-104 all-purpose centrifugal pump, is issued by Kenco, Inc., Lorain, Ohio. The Model P-104 is the most recent design in the company's line and features a completely submersible pump, hermetically sealed, that will handle a wide variety of liquids. The folder contains a complete description of pump, its capacity, design features, specifications and dimensions.....**Item 60**

RADIATOR APPLICATION MANUAL

Radiation Application Manual No. 1295, 32 pages, has been issued by C. A. Dunham Co., Chicago, Ill. It is exceedingly comprehensive in its treatment of convectors, baseboard and Fin-Vector radiation in showing proper methods of installation, piping, estimating, and applying.....**Item 61**

AIR CONDITIONING AIDS INDUSTRY

A large size, 12-page booklet entitled How Air Conditioning and Refrigeration Benefit Industry, has been issued by E. I. duPont deNemours & Co., Kinetic Chemicals Div., Wilmington, Del. It contains 24 case histories on the benefits of refrigeration to different types of industrial plants.....**Item 62**

VARIABLE TRANSFORMER BULLETIN

Bulletin P252 on its Type 10 Powerstat variable transformer is available from The Superior Electric Co., Bristol, Conn. It is complete with photographs, outline dimensions, ratings and other descriptive material.....**Item 63**

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MANUAL ON BRAZING

A new type of brazing manual, 16 pages, is published by All-State Welding Alloys Co., Inc., White Plains, N. Y. It is operator-written in the unedited language of the men behind the torch. In initiating this different approach the company feels it may have hit upon a solution to the problem of teaching the user what he needs to know so that he can get the most out of technical materials. The publication contains data for brazing shapes, sheet, castings, tubing and assemblies of copper, brass, steel, aluminum, and cast iron. The practical aspects of brazing, such as is found in the air conditioning, refrigeration and other service trades, are fully covered.....**Item 64**

REGISTERS AND GRILLES

Register Book 52, illustrating, describing, and pricing its complete line of registers and grilles for heating, air conditioning, and ventilating, is announced by The Auer Register Co., Cleveland, Ohio. The new catalog shows the range of this company's products and furnishes all necessary information to the customer. It includes several newly developed models, as well as changes and improvements in previous items.....**Item 65**

COMBUSTION INDICATOR

The Hazegage combustion indicator is described in detail in the two-page bulletin 801 available from Ess Instrument Co., Bergenfield, N. J. By indicating the degree of haze in the chimney gases, the instrument warns the plant operator to adjust the ratio of air and fuel. **Item 66**

PLACING WATER COOLERS

A new booklet, SP60-2123, describing how the proper placement of water coolers can save payrool dollars by cutting wasted man-hours is available from General Electric Co., Bloomfield, N. J. Entitled, the G-E Work Center Plan for Water Cooler Placement, this booklet is based on an extensive study of the drinking water requirements of industrial plants and offices. It contains sample floor plans for proper placement of water coolers, a five-step method of analyzing the drinking water requirements of any work center, and an easy-to-use table for computing the payroll savings gained by using the work center plan.....**Item 67**

UNIT HEATER POINTERS

Care and Maintenance of Steam and Hot Water Unit Heaters, Bulletin 12, is a four-page publication of Industrial Unit Heater Association, Detroit, Mich. Well illustrated and concisely worded, it covers the proper procedure in getting the most out of these efficient heating units. Diagrams show proper installation and piping, as well as methods of cleaning. A discussion on corrosion is included....**Item 68**

PRIMER ON RELIEF VALVES

A 10-page booklet entitled The ABC's of Temperature and Pressure Relief Valves, has been issued by The Patrol Valve Co., Cleveland, Ohio. The booklet is designed to give information concerning the hazard of over-heated water and excessive pressures on water heating systems, explains what relief valves are, why they are needed, and how and where they are used.....**Item 69**

OIL FIRED FURNACE

A new, three-color circular featuring the 492 Series Oil Fired Winter Air Conditioner is announced by Thatcher Furnace Company, Garwood, N. J. This folder lists 29 mechanical and operating features of the furnace and gives a brief explanation of how it heats a home. Engineering data and capacities are included.....**Item 70**

SELF-CLEANING STRAINER

A 4-page bulletin describes the complete line of self-cleaning pipeline strainers made by the V. D. Anderson Co., Cleveland, Ohio, in sizes from ¼-inch to 3-inch. A discussion of sediment control points out the numerous pieces of pipeline equipment needing strainer protection. These include steam traps, reducing valves, air tools, pumps, temperature regulators, etc. In addition, the bulletin contains complete specifications and prices on the product. Features discussed include mesh type Anderson stainless steel strainer screen, low initial cost, self-cleaning feature when blow-down valve is used, etc.....**Item 71**

WATER CONDITIONING DATA BOOK

A greatly enlarged edition of its Data Book has been prepared by the Permutit Co., New York, N. Y., superseding volume produced in 1949. Brought up-to-date and completely revised, it presents a compilation of 77 tables, with subjects covered including hydraulics, impurities in water, chemical conversions, saturated steam, boiler feedwater makeup requirements, chemicals used in water treatment, alkalinity relationships and specific gravities.....**Item 72**

SELECTING RIGHT AIR DIFFUSERS

A 64-page Selection Manual No. 40, containing comprehensive technical data for simplifying choice of proper air diffusers in air conditioning systems is issued by Anemostat Corp. of America, New York, N. Y. In its second revised edition, the manual contains a complete new section on the company's high pressure units for high pressure, high velocity systems. Generously illustrated with photographs, tables on performance data, and case examples, the manual includes sections on how to select the proper diffusers, types of diffusers, accessories, typical specifications, how to install, the anemotherm air meter, and prices and weights. Manual requests should be on your company letterhead.....**Item 73**

FLEXIBLE HOSE FOR DUCTS

A 4-page folder, Bulletin No. 34, has been issued by American Ventilating Hose Co., Inc., New York, N. Y., describing its Flexaust flexible hose and accessories for air conditioning, ventilation, dust collection, and fume control. The company also makes an almost unlimited variety of accessories including transitions, Y's, reducers, flanges, branches, and so on.....**Item 74**

INSTALLING, MAINTAINING TRAPS

An 8-page standard size leaflet, Bulletin 1722, on the installation and maintenance of Armstrong traps has been issued by Armstrong Machine Works, Three Rivers, Mich., giving terse and informative information on trap location, hookup, piping details, trouble-shooting, maintenance program and repair parts lists.....**Item 75**

COOLING TOWERS

Bulletin 33-102, describing its 1952 line of 33 Series induced draft cooling towers, is available from Havens Structural Steel Co., Kansas City, Mo. It contains full information for use in applying these horizontal air flow cooling towers to air conditioning and refrigeration systems of 5 tons capacity and up. **Item 76**

7-DAY CALENDAR SWITCHES

Bulletin 5207, describing its 700 Series time switches, is published by Paragon Electric Co., Two Rivers, Wis. The two-color, four-page bulletin includes illustrations of the 7-day calendar dial switches, descriptive material showing their applications, and diagrams which depict both the internal wiring of the switches and a suggested series of diagrams for their application to various heating systems. Operations from **on** to **off**, or the reverse, can be accurately set as close as three hours apart, and are completely adjustable throughout each 24-hour day in the week. With these switches, heating or ventilating operations can be turned on or off automatically different hours each day of the week. Any day or days can be completely omitted with these switches...**Item 77**

CONTROL SERVICING MANUAL

To furnish helpful suggestions for solving installation and service problems on gas controls, General Controls Co., Glendale, Calif., offers a 160-page service and instruction manual. The booklet deals with its automatic and industrial heating and industrial gas controls, and is revised and enlarged to cover the latest developments in control application. The manual is profusely illustrated, with detailed tables, photographs and drawings, covering thermostats, limit controls, electromagnetic, electric, gas and diaphragm valves, and other automatic control information.....**Item 78**

PLEASE SEND US MORE INFORMATION. Circle below item numbers on which you wish further information.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
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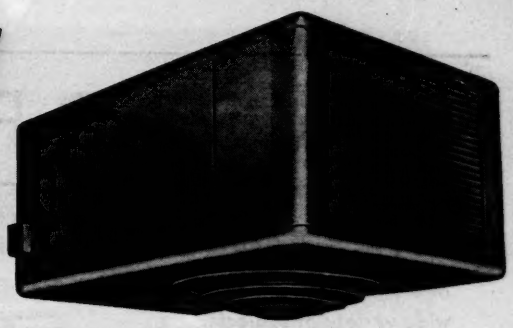
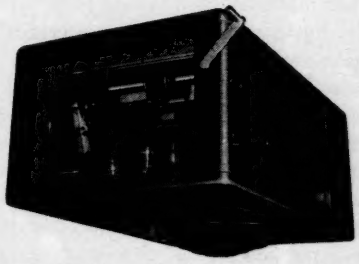
This card is void after August 1, 1952

Announcing—
the newest development in air conditioning!



VIKIMATIC SELF-CONTAINED CEILING AIR CONDITIONER



Note built-in winch, the feature which makes this Vikimatic unit practical! *Enables one man to remove entire power unit for servicing. Also eliminates costly rigging for installation, as winch is used to raise entire unit to ceiling.*

Not just another "air-handling" unit, but a *complete* air conditioner for ceiling suspension! Ideal for shops, super-markets, restaurants. This is Vikimatic's newest model,—and destined to be the most-copied of the year!

FEATURES:

- built-in winch, for installing, for servicing
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- 360° circular discharge grille, (half-grille optional)
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- hot water or steam coils insertable for year-'round a.c.
- all connections from ceiling or wall
- saves valuable floor space
- 3, 5, and 7½ ton sizes

Get the facts on this exciting new development, this fine sales builder for *right now*—Vikimatic's Self-Contained Ceiling Air Conditioner! See your Vikimatic representative, or write for full details *today!*

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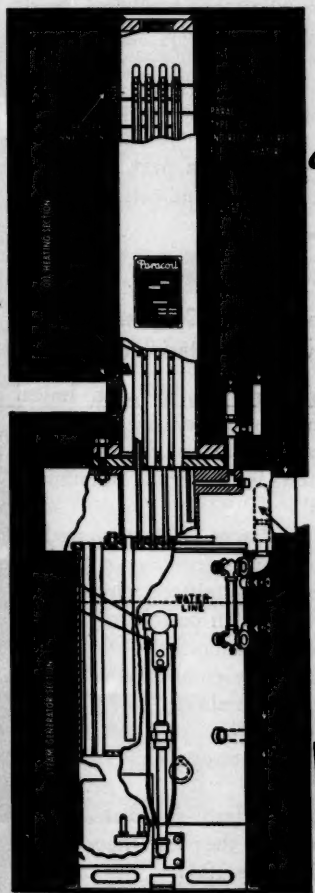

A GREAT NEW DEVELOPMENT IN OIL PREHEATER DESIGN

Paracoil Keeps Pace With The Rapidly Changing Needs Of The Oil Burner Industry

The TYPE "GF" INDIRECT GAS FIRED FUEL OIL HEATER

A RADICALLY NEW APPROACH TO THE PROBLEM OF ADEQUATE OIL PREHEATING UNDER ALL OPERATING CONDITIONS!

The Type "GF" Oil Heater is an integrated self-contained steam vapor generating exchanger using gas as its primary heat source.

However, the gas flame does not come in contact with the tubes containing the fuel oil. Instead, vapor from the lower steam generating section does the actual oil heating!

APPLICABLE TO ALL TYPES OF OIL FIRED APPARATUS!

As it is not dependent upon the unit it is servicing for the means of heating the oil, the Type "GF" Heater can be applied to any oil fired apparatus, be it a steam or hot water boiler, a process oven, a dryer or a kiln!

A COMPLETE SOLUTION TO THE OIL-IN-BOILER PROBLEM!

As the Type "GF" Heater is in no way connected to the steam or water space of any boiler it may be serving, there can be no possible contamination of the boiler heating surfaces in the event of an oil leak in the heater.

CHECK THESE FEATURES!

Completely factory assembled • Easy to install anywhere, even outdoors • Requires only minimum of floor space • Economical to operate • Wide range of oil heating capacities • Burns any specified type of gas fuel High oil temperatures at all times • Operation unaffected by normal variation in viscosities of oils being heated • Reduces oil consumption through improved fuel combustion.

THE PERFECT HEATER FOR:

- Low temperature forced hot water heating systems on No. 6 oil.
- Plants with starting difficulties after week end shutdowns.
- Supplementing inadequacies in present oil preheating systems.

Approved by Board of Standards and Appeals, City of New York—Cal. No. 362-51SA

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DAVIS ENGINEERING CORPORATION

NEWS OF THE MONTH

ASRE PROGRAM

offers informal conferences and technical sessions on wide variety of subjects.

A meeting of the American Society of Refrigerating Engineers will be held at the Biltmore Hotel in Atlanta, Georgia, June 1-4, 1952. Program chairman is George K. Iwashita of General Electric Co.

Continuing the practice successfully followed the last few years, informal conferences on domestic refrigerator and air conditioning engineering problems will run concurrently with the technical sessions. The subject of the domestic refrigerator engineering conference will be automatic defrosting. Packaged year-around air conditioners will be the subject of the air conditioning conference.

• **TECHNICAL.**—Three regular technical sessions will be held on Monday, Tuesday and Wednesday mornings, the afternoons being left open for committee meetings, inspection and sightseeing trips, golf matches, and other forms of recreation.

Among the papers being considered by the Program Committee for presentation at the Technical Sessions are:

"Atomic Radiation as it May Affect the Refrigeration Industry" by Dr. L. E. Brownell of the University of Michigan. This is a follow-up report on the talk given by the author at New Orleans in December which provoked a lot of questions from interested refrigeration engineers and food technologists; two or three papers on lubrication, selection and evaluation of oils for refrigeration systems; fundamentals of refrigerant pipings; properties of metals at very low temperatures; a discussion of pressure-volume-temperature properties of the Freon compounds; thermal electric analogue, a method of determining heat transfer electrically; a description of a new refrigerator cabinet heat leak calorimeter; some design and construction problems encountered in the erection of tonnage oxygen plants; how safety provisions as exemplified by the B-9.1-1950 Safety Code may prevent accidents; and the latest methods employed in freezing poultry.

WINDOW DESIGN

to be studied by Small Homes Council with emphasis on cost, ventilation and protection.

Problems in window design will be analyzed by the University of Illinois Small Homes Council under a new research grant made by the Lumber Dealers Research Council.

Among the problems earmarked for special attention are the cost of the opening into which a window is placed, and the control of ventilation, including protection from rain during periods when ventilation is needed.

• **COST.**—Emphasis will be placed on developing windows which are easy to manufacture, assemble, and install since simplifying the construction and the installation will reduce the "in-place" cost of windows. One principle which will be used to simplify construction is that of modular design—the relating of dimensions of windows to those of the house and of building materials so that the total assembly can be made with a minimum of cutting and fitting. (The relating of dimensions is possible by using 4 inches—or multiples of 4 inches—as the unit of measurement for building materials, windows and house.)

• **MATERIALS.**—Other materials in addition to wood will be used in the study, but materials which are critical in periods of mobilization and war will be excluded.

Various climatic conditions will be considered and the window will be adapted to different geographical areas.

James T. Lendrum, director of the Small Homes Council and professor of architecture, will direct the year-long study. Findings will be made available in 1953 to builders, architects and manufacturers in the form of detailed drawings, photographs and publications of time-study data.

• **OTHER WORK.**—The Small Homes Council has done considerable work on development of a window which extends to the ceiling and also conforms to the spacing of wall studs. By eliminating all headers over windows and also extra studs at each side of the window, the structural frame is simplified.

The window project is the fourth study in the Small Homes Council to be sponsored by the Lumber Dealers Research Council, a national organization of retail lumber men interested in housing research as a means of lowering construction costs. Other projects have been a study in house planning which resulted in a system of designing homes through the use of unit plans; research on an economical wall which can double as a partition and a closet; and a cost comparison of frame and concrete walls.

ASTM COMMITTEES

assemble 1224 technical men in Cleveland. Standardization and research work on materials announced.

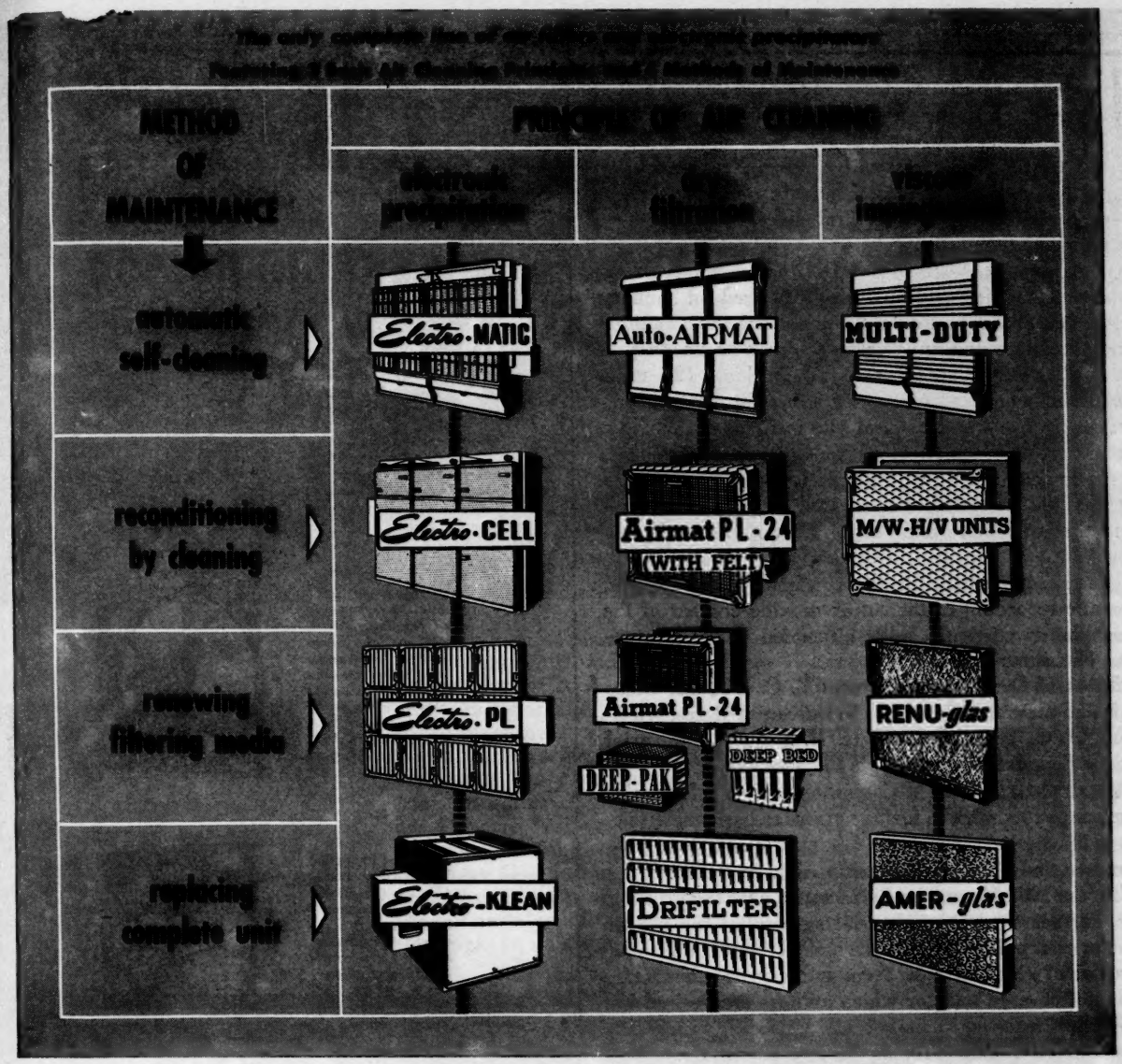
At the more than 250 meetings of ASTM technical groups during ASTM Committee Week in Cleveland, March 3 to 7, much new research work was discussed, and many new specifications and tests for materials and numerous revisions were completed.

This year the registration total was 1224 compared to 835 in 1951, but this figure varies from year to year depending upon the number of committees which meet. This year such large groups as D-2 on petroleum, A-1 on steel, and others met earlier in different cities.

A large number of meetings were concentrated during this week so that the committee members—leading technical men concerned with specifications and tests—could attend the various meetings with considerable saving of time and expense.

Most of the new and revised standards completed at the meeting are subject to letter ballot in the committees before

(*Continued on page* 120)



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...Select from the ONLY COMPLETE LINE of air cleaning products

Engineered air cleaning equipment is the practical answer for today's complex problems of air contamination. This is the advantage offered by AAF's complete line, which includes more than twelve distinct air filter types. These range from the highly technical electronic precipitator to simple replaceable units . . . many of them being exclusive AAF developments. Each type is distinguished by its principle of cleaning air or method of maintenance, thus allowing the engineer wide latitude in selection to meet individual requirements.

If you require *clean air* . . . look to AAF for the most practical and efficient answers. AAF representatives located in all major cities will be glad to serve you, or write us for our new 32-page "Composite Catalogue"—American Air Filters—Bulletin 510.

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(*Continued from page* 118)

they are referred to the parent society for action. In general the new specifications will be considered finally at the ASTM 50th Anniversary Meeting in New York City during the week of June 23, although some may be approved prior to that meeting through the Administrative Committee on Standards.

• **AIR SAMPLING.**—Committee D-22 on methods of atmospheric sampling and analysis, organized on January 9, 1951, has made substantial progress. The subcommittee on nomenclature and units organized task groups to prepare tentative standards for (1) definitions, (2) units for expressing concentrations, (3) abbreviations and symbols. Other sub-committees deal with methods of sampling, (six task groups) analytical methods (seven task groups), and instrumentation (five task units).

Drafts have already been prepared for proposed standard methods of determining carbon monoxide and hydrogen sulfide.

A proposed method for the continuous analysis and automatic recording of the sulfur dioxide content of the atmosphere is currently being circulated to the subcommittee on instrumentation.

Officers of Committee D-22 are: L. C. McCabe, Office of Air and Stream Pollution, U. S. Bureau of Mines, Washington, D. C., chairman; and H. H. Schrenk, Industrial Hygiene Foundation, Pittsburgh, Pa., secretary.

• **REFRACTORIES.**—ASTM Committee C-8 on refractories has expanded its work to include granular basic materials, such as magnesite, through the organization of a new subcommittee under the chairmanship of J. J. Hazel.

With the 1952 Manual on Refractories near the printing stage, further work on industrial surveys of the use of refractories is pointed toward the completion of additional fields, two of which are coke ovens and open hearth mixers. Fields not covered and for which authors are desired include blast furnaces, cupolas, and annealing furnaces, paper industry, and methods of installation. New test methods are expected to be completed at the next meeting.

Officers of Committee C-8 are: R. B. Sosman, Dept. of Ceramics, Rutgers University, New Brunswick, N. J., chairman; W. R. Kerr, Armstrong Cork Co., secretary.

• **INSULATING MATERIALS.**—Handleability of block and pipe thermal insulating materials is recognized as being an important property, and ASTM Committee C-16 has been studying methods of evaluating this. At the committee meeting during Committee Week in Cleveland, two instruments were agreed upon for determining data by which field handleability can be evaluated, these being an impact pendulum and a drop machine type.

The Subcommittee on Block and Pipe Insulation reported on an impressive list of proposed test methods and specifications, including a method for measuring the resistance to vibration. A change in the size of the mold will be made in the specification for Mineral Wool Molded Type Pipe Insulation (C 281 T). Several proposed specifications were accepted covering various types of pipe insulation, including laminated asbestos paper type insulation, 85% magnesia block and pipe, mineral wool block or board for low temperatures, mineral wool board for roofs, mineral wool block or board for elevated tem-

(*Continued on page* 122)

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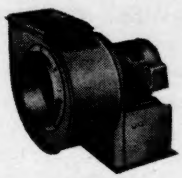
Direct Drive Unit Blowers *are available in 11 models. Wheel size from 6" to 11". Choice of speeds available in each size. These units may be mounted on floor, wall or ceiling.*



Direct Drive Propeller Fans. *Both small sizes for use in offices, laboratories, etc. and also heavy duty units commonly used where contaminated air cannot penetrate the totally enclosed motor. Sizes from 14" to 36". Capacities up to 12,400 c.f.m.*

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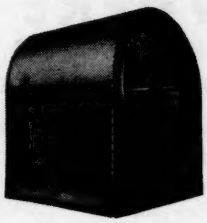

Write for detailed information about any type Herman Nelson Fan to Dept. HV-5.

AAF

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HERMAN NELSON

Division of AMERICAN AIR FILTER COMPANY, INC.

MOLINE, ILLINOIS

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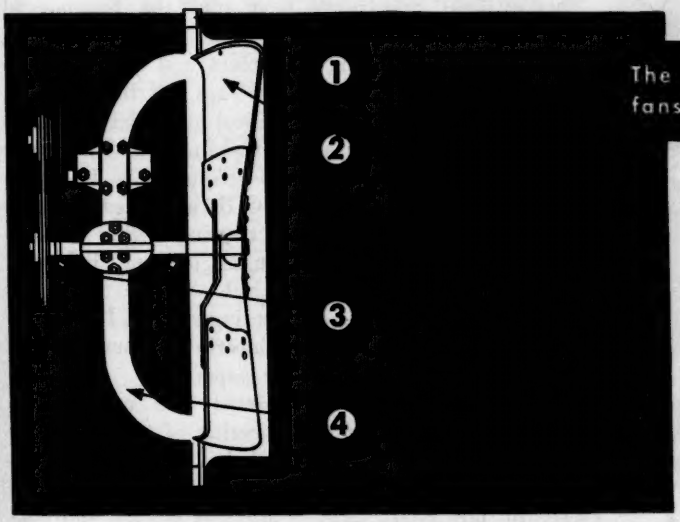
In the industrial plant shown above 43 Herman Nelson Propeller Fans insure comfort cooling for employees working at heat-producing, high speed machines.

No matter what type or size of ventilating fan you need for industrial, commercial and institutional use Herman Nelson makes it. Our designers and engineers are leaders in the fan field and in our laboratories and test rooms all the latest findings of aerodynamic science are put to work in fan design. Herman Nelson fans are noted for low initial, operating and maintenance costs. They are designed to operate with minimum air turbulance, thus permitting the delivery of more air with less noise.

The Herman Nelson line includes Propeller Fans, Unit Blowers and Class I and II Centrifugal Fans. All Herman Nelson fans are tested and rated according to Standard Code of the National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers.



The key superiority of Herman Nelson propeller fans is the exclusive design of the fan blade.

The blades have an "air-foil" cross section which results in greater efficiency and quieter operation. The tendency toward over-loading, common in propeller fans, is minimized by advanced Herman Nelson design. Lower initial, operating and maintenance costs are assured.

Fan blades of all Herman Nelson Propeller Fans are fabricated of aluminum and are formed by the hydraulic pressure method for extreme precision. The outer edge of each blade is flanged to increase strength and rigidity.

AAF herman nelson moline illinois

HERMAN NELSON

Division of **AMERICAN AIR FILTER COMPANY, INC.**

MOLINE, ILLINOIS

(*Continued from page* 120)

peratures, and diatomaceous earth block and pipe. A proposed sampling procedure was also accepted.

Subcommittees interested in structural insulating board and blanket insulation reported developmental work on small scale methods for determining flame resistance. A racking load test for structural insulating board sheathed wall panels has been prepared.

Round-robin tests in six laboratories using a proposed method for determining specific heat has been completed and the data will be studied. In preliminary work on a maximum use temperature limit test, it has been found advisable to remove the shrinkage-after-soaking procedure and place it in a separate method. The procedure for measuring warpage will also be set up as a separate method. A proposed method for testing water vapor transmission for materials thicker than ⅛ in. is now ready.

Officers of Committee C-16 are: E. R. Queer, Pennsylvania State College, State College, Pa., chairman; and H. G. Hill, Ehret Magnesia Manufacturing Co., New York, N. Y., secretary.

RECORDED GRIPE

operates by thermostat to needle landlord for more heat.

A thermostat-controlled record player that automatically calls down to the landlord when the upstairs apartment gets too cold convulsed 200 spectators in a Brooklyn court.

On the complaint of Melvin A. Carter, a 36-year-old photographer and electronics engineer, Clarence Cadogan, 45, his landlord at 913 St. Marks Avenue, appeared in Pennsylvania Avenue Magistrate's Court on a charge of providing insufficient heat.

Mr. Carter, who lives with his wife in a six-room apartment on the top floor, said that since Oct. 16 the heat had been inadequate.

After making frequent complaints in person to his landlord, Mr. Carter made a recording of them. He installed amplifying equipment in the dumb-waiter shaft, to beam its sound to Mr. Cadogan's apartment on the second floor, and rigged his whole sound system to the thermostat.

• **LAW.**—For the last three weeks, when the temperature dropped, the recorded voice of Mr. Carter has automatically intoned: "Mr. Cadogan, under Section 225 of the Sanitary Code a landlord who doesn't provide 65 degrees of heat when the outdoors temperature falls below 55 degrees is liable to a $500 fine or a year in jail. The temperature in this apartment is now below 65 degrees."

The landlord endured it for a while. Then he called a policeman, who suggested only that Mr. Carter turn down the volume. Other tenants made no protest over the recording.

But the Carter apartment still felt cold, so Mr. Carter went to court. Magistrate Paul Balsam, impressed with the recording device, called a conference in his chambers. Mr. Cadogan insisted the heat was adequate, but said he was willing to re-examine his heating system.

HOUSTON

supports claim as nation's most air-conditioned city. Home cooling leads in tonnage installed.

Houston added more than 21,527 tons of new air-conditioning equipment during 1951 to continue the Texas metropolis in the leadership as one of the most completely air-conditioned cities in the United States—if not the first.

This was revealed in a survey conducted by Magazine Houston, monthly publication of the Houston Chamber of Commerce, which reported its findings in its March issue.

• **RECORD.**—The 1951 total was 2,403.4 tons more than was installed in 1950. Houston now has approximately 158,400 tons of air-conditioning equipment.

As in previous years, home air-conditioning, including window units, led all other classifications and was greater than in any other year. More than 10,000 homes last year installed a total of 10,346 tons, compared with 7,441 tons in 1950; 4,425 in 1949; 4,845 in 1948; 2,755 in 1947, and 380 in 1946.

Individual offices ranked second, with 196 offices installing 3,131.75 tons. Here, too, small individual room units prevailed. Other office buildings accounted for 2,327 tons in 11 buildings. Thirty churches installed 1,111 tons to be ranked fourth by classification. Food stores were fifth with 934 tons and educational buildings sixth with 788 tons.

OIL HEAT

convention and exposition draws industry to Philadelphia for technical and trade review.

Some 3500 registrants filed into the Commercial Museum in Philadelphia to view one of the largest aggregations of oil heating equipment and appurtenances ever assembled for the biennial show of the Oil Heat Institute of America, Inc. Technical and sales personnel also gathered at the Benjamin Franklin Hotel for a 4-day series of discussions and meetings April 14 to 17.

T. A. Crawford, president of OHI, welcomed members at the opening of the annual meeting. Other sessions were divided among distribution, engineering, industrial and commercial assemblies.

• **ENGINEERING.**—At the engineering session, L. N. Hunter, chairman of the OHI Engineering Committee, presided over presentation of four papers.

E. C. Webb, recently appointed vice president in charge of production and engineering of the Iron Fireman Manufacturing Co., presented a paper on storing and handling heavy fuel oil. After a preliminary discussion of flow characteristics affecting storing and handling, Mr. Webb pointed out that one of the difficulties in the industry arose from the fact that present commercial standards for fuel oil set no limit on the pour point of No. 5 oil. The consequence is that engineers designing systems for handling No. 5 oil are never sure whether pre-heating of the oil will be required. Hence, an extremely wide range of fluidity must be taken into con-

(*Continued on page* 124)

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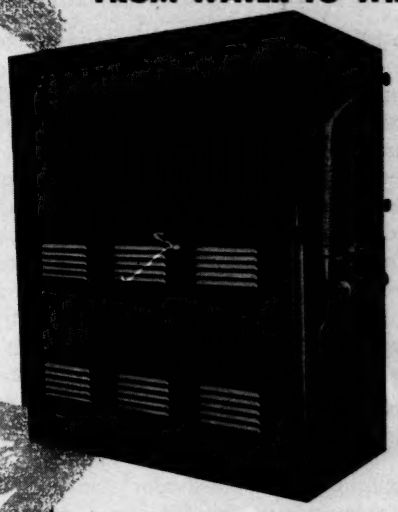

Now — a compact, completely self-contained water chilling unit for a host of industrial and retail liquid cooling tasks. Rugged Typhoon engineering features include spray nozzles that require no cleaning, insulated water jacket, oversize all-copper condensers and cooling coils. Use these units singly (sizes to 20 tons) or in multiple units to meet any tonnage requirement. Easy to install, outstanding for trouble-free performance and long-life.

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- **COOLING CUTTING OILS** and other liquids for industrial purposes.
- **CHILLED WATER** for drinking fountains.
- **COOLING OF WINE** or other liquids in bottling plants.

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(*Concluded from page* 122)

sideration when designing the oil handling system for an industrial oil burner installation. Other factors affecting storage and handling are viscosity and its effect upon atomization at the burner, flash point, and corrosion characteristics.

• **SPECS.**—Fuel oil specifications were discussed by J. Verne Resek, Manager, Oil Burner Division, Cleaver-Brooks Company, Milwaukee, Wis. Mr. Resek pointed to commercial standards for fuel oils established in 1929 and revised in 1948. A proposed new commercial standard, now under consideration by the industry, makes minor changes in the present standards for No. 1 and No. 2 oils. The specification for No. 3 oil was discontinued in the standard developed in 1948 and is no longer used. No. 4 oil, specified in the 1948 standard to bridge the gap between No. 2 and No. 5, will be discontinued in the proposed new standard. No. 5 oil will have recommendations for lower maximum pour point and viscosity to eliminate the present confusion which exists regarding handling of this oil. A new limit on the viscosity of No. 6 oil is proposed to be set at 45 Saybolt Furol maximum at 122F as against the present limit of 300 Saybolt Furol at that temperature. A new high viscosity No. 7 oil is proposed to bracket the higher ranges of the present No. 6 standard.

Other papers presented at the technical session were: The Performance of Pressure Atomizing Nozzles in Atmospheric Oil Burners, by Eugene O. Olson, chief engineer, Delavan Manufacturing Co.; and Improving Start-Stop Characteristics of High Pressure Burners, by E. B. Delgass, H. C. Whittet, and H. G. Murray of the technical service department of Socony Vacuum Laboratories.

COAL GASIFICATION

promises to tap huge resources of low-rank coal international conferees agree.

Scientists and technologists of the Bureau of Mines and of several European countries who have been studying the direct gasification of coal, have presented some recent conclusions on the subject, which promise new benefits at a time when new sources of power and fuels are vital to this Nation's expanding defense program and the programs of our allies.

The conclusions, reported at two recent international scientific conferences held in this country, have been released by the Bureau of Mines.

• **POINTS COVERED.**—They include the following:

(1) Direct gasification, as opposed to processes in which coal is coked before gasification, is one of the most important steps in obtaining such products as gas, gasoline and chemicals from coal.

(2) Huge resources of low-rank coals and lignites, which cannot now be exploited economically by standard techniques, are available for direct gasification.

(3) Both the United States and European countries are developing high efficiency for the gasification of coal won by standard mining methods through large capacity equipment. Feasibility of operating under atmospheric pressure and at 30 atmospheres has been demonstrated.

(4) Experiments, using air on underground gasification of coal in the bed have been carried out, with the resultant yield of practical and fundamental scientific knowledge, in Belgium, French Morocco, Italy, the United Kingdom and the United States.

(5) Additional systematic experimentation in these countries has involved (a) the percolation system using electrical, hydraulic, and pneumatic methods for connecting the vertical boreholes, thus avoiding the construction of underground tunnels; (b) the classical steam method in which preheated air is blown at high velocity through a prepared passage; and (c) a process using parallel passages opened along the pitch of the bed and uni-directional flow of oxygen and steam.

(6) The common aim of the several systems is to produce gas at low-cost, with either air or oxygen, depending upon the type of gas required. The combined results of experimentation show that this is feasible and that the systems are adaptable to a wide range of geological conditions and purposes.

(7) Successful development of the coal gasification processes in time may reduce underground work, increase productivity, and open to economic access sources of energy previously unexploitable. In turn, both the underground and above ground processes will make the world's large coal reserves a basic commodity for meeting ever-increasing demands for liquid and gaseous fuels, and will open new employment opportunities.

(8) When eventually developed for commercial application, it is estimated that underground gasification may save Europe several billion dollars a year on its annual coal budget and may benefit the United States by providing some new methods for exploiting fuel resources.

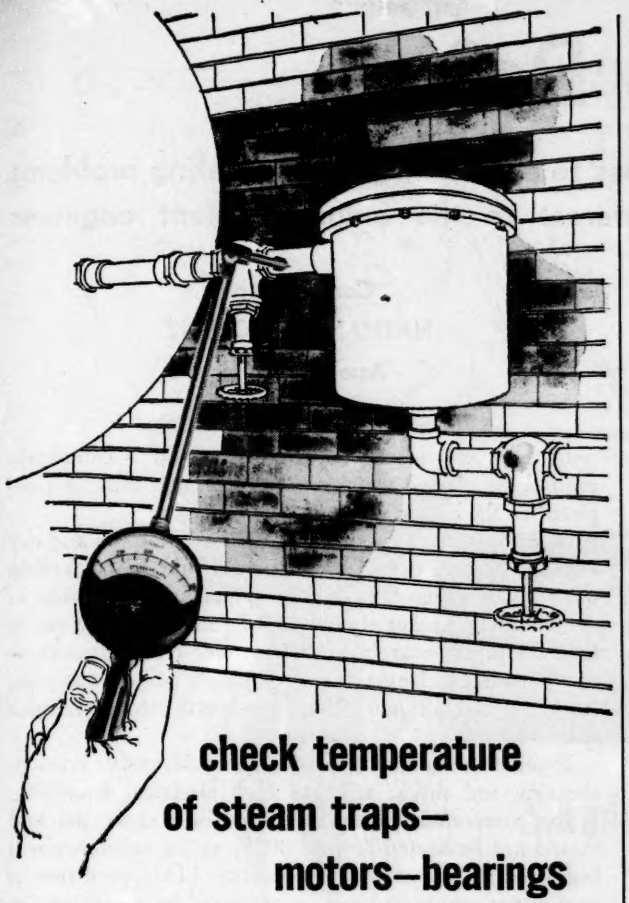
• **SUPPORT URGED.**—Support for the research program on coal gasification was urged at the two conferences on gasification which included the First International Conference on Underground Coal Gasification, which met at Birmingham, Ala., and a symposium on coal gasification subsequently held at New York in connection with the meeting of the American Institute of Mining and Metallurgical Engineers.

The Mutual Security Agency and the Organization for Economic European Cooperation helped to organize the international meetings.

• **PAPERS PRESENTED.**—Among papers presented by European and American scientists on underground gasification research were resumes of experiments in Great Britain, Russia, Italy, Belgium and France, a review of experiments in the United States, and in French Morocco.

Dr. E. T. Wilkins, principal scientific officer, Fuel Research Station, London, England, described English experiments using flat coal seams.

This research began in 1949 with the ultimate objective of producing electric power to help relieve Great Britain's fuel and power shortage by using coal that cannot be mined economically by conventional methods.



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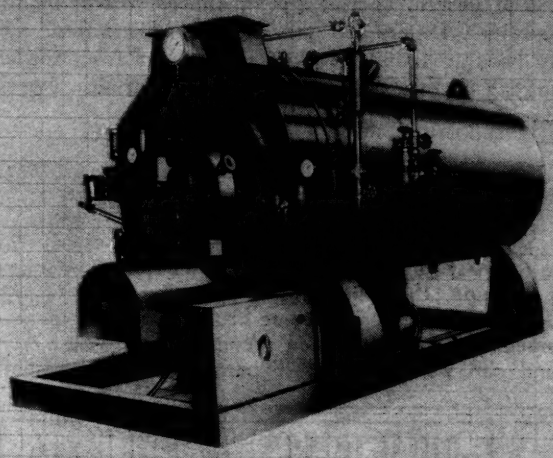

Yes, 3 square feet of heating surface with Cyclonic Combustion equals the 5 square feet of heating surface offered to you by other packaged boiler units.

The Cyclotherm Cyclonic Combustion Principle is an entirely new and amazingly different method of heat transfer in the boiler industry.

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What Would You Do?

Replies to engineering and operating problems of interest to the industrial plant engineer

Conducted by
NATHAN N. WOLPERT
Associate Editor

THIS department is planned to be helpful to the industrial plant engineer by providing possible solutions to troublesome problems. Questions are invited and those of general interest are announced several months in advance. Letters are welcome either from those who may have an industrial plant problem or from readers who may have suggestions relating to solutions of problems scheduled for future discussion.

This Month's Problem

In the past we have been using cement joints, when laying tile pipe. This joint does not permit settling of pipe and we have experienced some broken pipe. Hot poured compound joints have been recommended. What compound can we use? Will it permit some movement?

Solution to This Month's Problem

Three different types of compounds are used for hot poured joints for use with tile pipe. They are Cla pipe jointing compound, type GK pipe joint compound, and Tegul-Vitrobond.

The first of these is a product of the Clay Products Association, Chicago, Ill., and the other two are made by the Atlas Mineral Products Co., Mertztown, Pa.

The first is shipped in cans all ready for the heater. The compound, as taken from the can, should be broken into small chunks with a hammer and put into a heating kettle. After the inside of the bell and the outside of the spigot are wiped clean, the joint should be packed with jute in the usual manner. The compound is heated to about 350F or slightly higher, and the joint is poured in the usual manner.

This compound pours easily when heated to the right temperature and it fills the entire annular space without leaving bubbles or air pockets. The joint acts quickly, is strong, and is resistant to acid, alkali and roots. The joint may be either in a horizontal or vertical position when made. When properly poured, the compound adheres to the glazed surface of the vitrified pipe, even under the worst conditions.

Type GK compound has a bituminous base, and melts and runs freely at a temperature as low as 250F. It adheres firmly to the glazed surfaces of the pipe and when cool has sufficient elasticity to permit a slight movement of the pipes without injury to the joints or breakage of adhesion of the compound to the pipes. It does not deteriorate when submerged in water or domestic sewage.

The compound should be heated in a suitable heater to a temperature of 350 to 400F so that it can be poured rapidly and smoothly. Some engineers require that the heated compound shall be poured off center on one side until there is evidence that the compound is completely around the pipe at which time the pouring may be completed in the center.

Before pouring, the pipe joint should be clean and dry and a gasket of dry hemp or jute should be caulked in the annular space between the spigot and the inside of the bell. The gasket should be of sufficient thickness to hold the pipes securely in their proper relative positions and of sufficient length to go completely around the pipe. It should not fill more than one-fourth of the annular space.

Tegul-Vitrobond, which is inert to acid, resists erosion, abrasion and shock, and has high electrical resistivity.

The compound should be melted in a clean pot and should not be heated beyond 300F, as the substance will begin to thicken at that temperature. This condition is readily noticeable and can be corrected by removing the heat source and stirring. On cooling below the thickening point, it will again become thin and will flow freely.

Pouring should be done at a good speed and continuously until the joint is full. As the jointing material cools and contraction occurs, resume pouring. In other words, the joint is completely poured before there has been any opportunity for cooling. Pouring should be resumed as necessary to take care of any contraction in the joint material. Joints should not be poured unless the ground water level is below the bottom of the bell.

The joint may be yarned in the usual manner with joint or asbestos rope. However, a tighter joint can be obtained if these materials are not used and Alkor acid-proof cement is trowelled on the spigot end of the pipe instead, before it is shoved home. This mortar sets to a hard material in a short time and seals the base of the joint.

J. E. York
Building Service Engineer,
Stone & Webster Eng. Corp.
Boston, Mass.

Problem for the Coming Issue

At this plant, the section which handles the welding of small and medium size parts is to be remodeled. The section manager wants better ventilation for the welders. Can you suggest a suitable or practical system that will serve a number of booths? What air velocity would you use?

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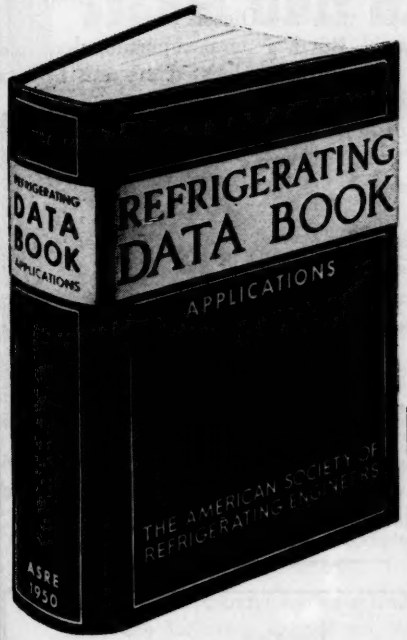

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PRODUCT APPLICATIONS

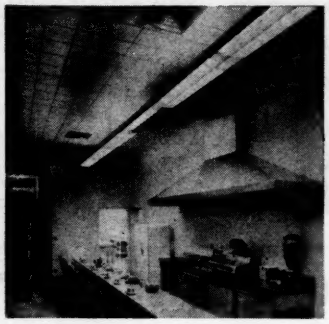
New, Unusual, or Ingenious Uses of Equipment and Materials

Conducted by WM. B. FOXHALL, Associate Editor

Blood Donor Center Air Conditioned

PROBLEM: At the American Red Cross blood donor center in St. Paul, Minn., facilities were recently expanded to meet increased demands for blood. It was decided to provide the most favorable room temperature at each stage of the blood donation process.

SOLUTION: The system, designed and installed by the Pierre Aircon Co. of St. Paul, utilizes three zones of reheat to provide gradual temperature drops as the blood donor proceeds from the street, through the reception and testing rooms to the donor center proper where a relatively low temperature is maintained to minimize the tendency for donor blackouts following the blood donation. The system was designed to operate completely automatically. A U. S. Air Conditioning Corp. 10-ton refrigerated Kooler-aire unit was installed operating from a 7-day program timer, so that it is in operation only during the hours that the center is actually in use. An outdoor controller operates the compressor whenever the outside temperature is above 75F. In the office area where the donor first enters, the building, the temperature is 75F, dropping to 72F while he is processed for typing and testing of the blood, and further to 68F in the donor center itself.



RESULTS: The system has been in operation continuously for several months. While the outside temperature remains between 55 and 85F, the system operates on 100% fresh air controlled by automatic dampers. If the outside temperature falls below 55F or rises above 85F, the system is designed to run on 1,000 cfm of outside air. The desired graduated temperature conditions have been maintained throughout the period of operation.

Giant Vats Baked in Cement

PROBLEM: An interior coating is applied to giant industrial vats to protect the metal from corrosion. Industrial Coatings, Ltd., Vancouver, B. C., applies protective coatings for vats and other equipment used in pulp and paper mills, breweries, chemical plants, and canneries. Interior coatings must be baked on and the problem of baking huge vats without wasteful use of fuel is a serious one.

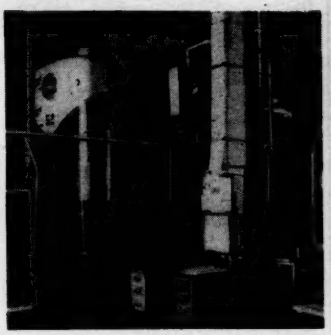
SOLUTION: Vermiculite high temperature cement, a product of the Zolonite Company, Chicago, is blown on the outside of the vats treated at the Vancouver plant. After a 3/8-inch layer of vermiculite is applied, the first coat of phenolic resin is applied on the inside. Raw flame is then applied to the interior with a specially designed burner. As the resin bakes, the cement dries. A second coat of insulating cement is then sprayed on and another interior resin coating is applied. Each inside coating takes six hours and there may be as many as 10 separate bakings. Temperatures range from 350 to 500F. Vats range in size from 8 to 20 feet in diameter and 20 to 40 feet in length.

RESULTS: Without insulation it would be almost impossible to maintain the temperatures required and the radiation from outside surfaces of such large vats would not only prevent the building up of proper heat levels but would result in enormous fuel consumption. Vermiculite prevents excess heat loss and maintains proper temperature inside.

Unit Heaters Curb Monoxide

PROBLEM: Until three years ago, Diesel locomotives, with engines operating during the warming-up period in the Diesel shop of the Port Huron and Detroit Railroad Co., poured monoxide gases into the shop. Fumes had to be eliminated by high velocity exhaust fans. Heat delivered by Modine unit heaters installed for comfort heating was also being eliminated with the Diesels' fumes.

SOLUTION: William N. Boyd, general superintendent and chief engineer of the railroad, relocated the unit heaters so that the heat delivered by them would be directed at the radiator grilles of the Diesels. The heated air from the unit heaters passes through the radiator grilles and radiator, over the engine, through the cab and out into the shop.



RESULTS: Running the Diesels to warm them up is no longer necessary and the monoxide gas problem has been eliminated. When the engineer presses the starter button the Diesels are warmed up and ready to roll out of the shop.

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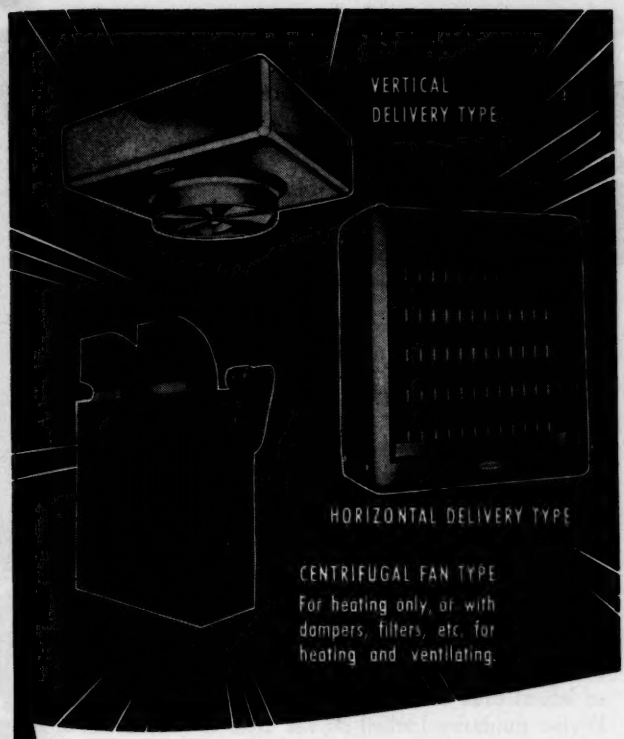
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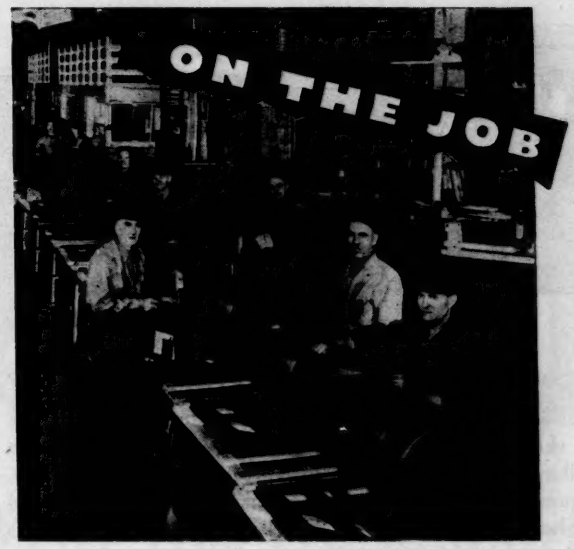

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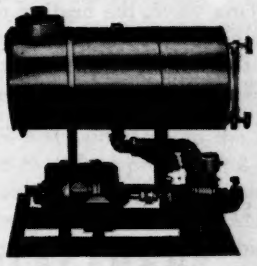

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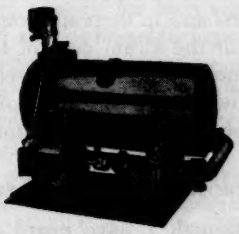

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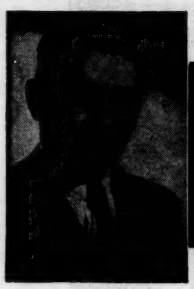

Experience is my Classroom

By T. W. REYNOLDS

• CONVERTING FROM HIGH TO LOW PRESSURE STEAM

Boiler depreciation and a desire to discontinue the use of skilled labor sometimes bring about a change in a boiler plant from high to low pressure steam operation. However, any contractor undertaking such work should analyze the situation closely or he will end up with a loss and an unsatisfactory job.

In a change over on a water tube boiler, the tubes may be too small to handle the larger volume of steam, hence water may be carried over and the circulation so slowed down that overheating of tubes result. The capacity of steam pipes and traps will be reduced and some traps may no longer operate. On the good side, the heat transfer in the boiler will be greater due to increased temperature differential of gases and water.

Controls may require resetting and a stoker drive changed from steam to electric. On the boiler, steam gages will have to be changed and safety valves readjusted. Boiler steam connections will have to be larger to prevent carry-over. The same is true of the return connections which no longer have a high pressure steam pump to force water through them.

If there is a pressure reducing valve, the heating coils at fans and in domestic water heaters will be satisfactory, as will the steam control to the heater. Otherwise they will not be, and any consequent addition to the number of rows of air heating coils will increase the required horsepower of the fan motor.

• KEROSENE MAKES BOILER STEAM

Although I have heard and experienced a few trick ways of making an undersize boiler develop pressure, the one told me by Harold Alt of an expedient he used in China is one that seems to have been overlooked in this country. Working in Shanghai for a contractor, he had to take a 3-day trip (mostly by boot up the Yangtze Kiang) to diagnose and remedy the case of a missionary building that could not be heated at the far end.

Arriving at his destination, Alt found that the first thing necessary to the success of his undertaking was that he comply with the missionaries' request to get down on his knees with the others and pray for a good solution of the trouble, now that the expert was here. This over, he looked over the heating plant and found the cause to be a combination of small boilers and poor coal.

What was he to do in such a situation with boilers that had travelled a long ways and a contractor back in Shanghai that wanted his final payment of $5,000. Nor was he interested in taking further trips of days each way, during which the conversation was so limited to Chinese that he occasionally talked to himself to keep in shape.

In this situation, Alt thought how simple the problem would become if he only had a liquid that would evaporate at a low boiling point and therefore circulate to the far ends of the heating system. Mumbling to himself and pacing the boiler room floor he stumbled over a can of kerosene. There it was, the ideal liquid, and more of it was soon found available.

Calling his No. 1 Chinese man, he had him remove the safety valve of each boiler, and through the opening so left at each boiler, pour five gallons of kerosene while Divine guidance looked on askance. It did the trick and the contractor got his final payment.

Back in Shanghai, Alt ran into another case of the system not heating the far end of a building. This time it was the vapor heating system of a bank building. All that was required to cure this trouble was to turn a check valve around so that it would vent the air from the system. This valve had been installed backwards in the Chinese way, so that with pressure raised all of the air in the system was compressed to the far end of the system.

A second case of vent or air relief trouble in a vapor system also involved a three-day boat trip each way, this time on the Manchurian Sea. To a local Chinese worker the open end vent pipe appeared as unfinished business, so he closed it with a cast iron plug. To the question of, "Why?" he replied "No likee open pipe."

• SYNTHETIC PERSPIRATION

During World War II, the writer, as consultant to the War Production Board, quite often found it necessary to grant much needed critical materials for the manufacture of air-conditioning equipment just to prevent perspiration on the workers' hand. Such perspiration and its corrosive content was said to vary with the nationality of the worker. In any event, upon contact of moist hands with machined parts, a definite corrosion was soon evident. So there were many rejected parts to the detriment of the war effort.

It is therefore interesting to report the development of suppressants of finger print corrosion as made by the Socony-Vacuum Laboratories at Brooklyn, N. Y. Their aim is to increase the usefullness of their slushing oils, provide an oil formula that will neutralize or remove sweat from metals before it can cause damage to these metals, and also give these metals permanent protection again subsequent handling.

Of course, such suppressants do not necessarily eliminate the need for the use of other types of rust preventives

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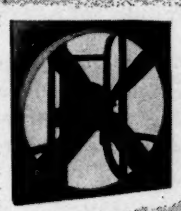

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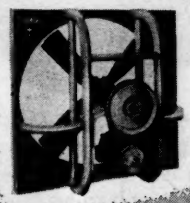

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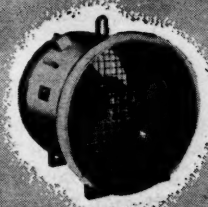

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In addition to the known service record, Barnes and Jones is a progressive company. B & J developments include the perfection of reliable temperature controls for both vapor and vacuum systems; methods of automatic soldering and high frequency welding of the important thermostatic diaphragms, and light weight float and thermostatic traps that can be installed close to the ceiling with fewer supports.

And as a final proof that B & J Quality is accepted, the company is moving into a five story plant which already has many new and most modern machines in operation.

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One of the most appreciated products of B & J is the Cage Unit which will replace the entire internal mechanism of any other trap housing. You don't even use the old valve seats—and the unit is factory adjusted. There is nothing to do but grab a wrench, test your traps with the B & J testing set, and replace the bad ones with the B & J Cage Unit. Ask for the Bulletin—"Heating Magic." It will save time and money and do away with most of your heating system complaints.

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or for air conditioning in certain sensitive cases. They affect only the source of corrosion cited. Nevertheless, finger print corrosion is a major source of difficulty in the production of precision equipment. It only takes 24 hours for the corrosion from a finger print to damage finely made bearings, gears or piston rings.

The effect of perspiration lies in the provision of an electrolytic solution in contact with metal, which as is well known, accelerates corrosion similarly as with sea water. The quantity and nature of perspiration, and therefore the magnitude of its corrosive effects, probably depends upon diet as well as certain congenital individual differences. Differences in these qualities can be expected within populations of different national origins and also between such groups.

The magnitude or the effect of such variations is still a question to a certain extent, but it is known that the curly red head is quite an offender as compared to a blond or brunette. It is also known that finger print corrosion is most active during the spring and fall seasons when sudden changes in temperature occur overnight. Moisture then formed activates the crystals of drying finger prints to make them more corrosive. Much of the tiny crystal deposits are made up of salt which attracts more moisture from the air, thus speeding up corrosion by making the moisture a conductor of electricity as in any electrolytic process.

The difficulty encountered with perspiration is not only its variation with the individual, but also with its chemical change from day to day according to body temperature, activity and metabolism of the individual. This shows the need for a standardized kind of sweat to make corrosion experiments in the laboratory more accurate. This can now be produced for application to various kinds of metal plates as a check on corrosion rates. The plates are then given a filming treatment with the standard new slushing oils.

Three different synthetic perspirations, as follows, have been originated from compounds of lactic acid, urea, salt and water. The first of these closely approximates the composition of normal human perspiration.

Sodium Chloride	7 gm	7 gm	7 gm
Urea	1 gm	1 gm	1 gm
Lactic Acid (85%)	4 gm	4 gm	4 gm
Distilled water	1 liter	175 ml	500 ml
Ethanol (95%)	.....	525 ml	.....
Methanol	.....	.....	500 ml

• AIR DIFFUSERS ON HIGH CEILINGS ARE QUIETER

A ceiling air diffuser with too high a neck velocity may emit a certain amount of noise in one space, but not in some other space. The difference in mounting or ceiling height of the two installations could be the cause. This is a good thing to remember, especially in the case of broadcasting studios.

Sound of course, travels in waves which diminish in intensity as they move away from the source of noise. Thus, the higher a given ceiling air diffuser is mounted, the quieter it will be for the same air quantity. Stated another way, the greater the neck velocity of the air diffuser, the smaller can be the outlet that is used, without resulting noise. This, also explains why ceiling outlets may be quiet enough in some cases, and why the outlets mounted on the wall below the ceiling may produce a certain amount of noise.

• IDENTIFICATION OF EQUIPMENT

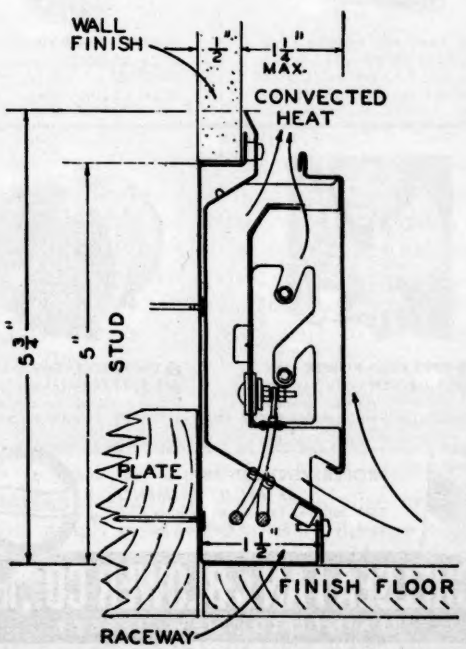
Apparently, many manufacturers do not think too much of their equipment. On old equipment their name may or may not be found, but the real grievance is the name plate and identification number, seldom in the same place, seldom legible after some years or even when first stamped. Usually the information is located (1) to catch the most grease and dirt, (2) too close to some moving part, or (3) where things are too hot to handle. Often it is inacessible.

Anyone who has ever done inventory or appraisal work knows that at least 15 minutes is the average time for taking name plate data. Generally, such data is stamped upon the poorest of background for proper flashlight reading. Three different readers are apt to report as many different numbers and letters.

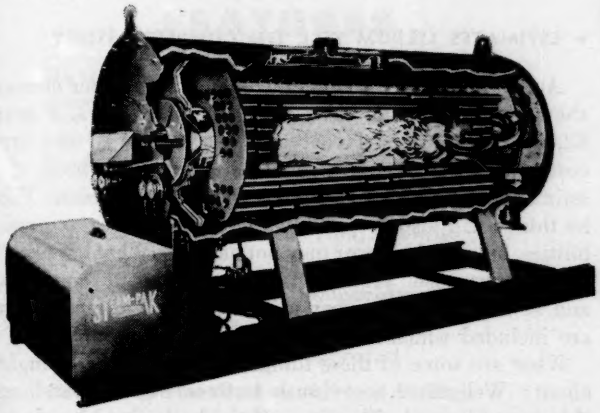
• ELECTRIC BASEBOARD PANELS

An interesting letter was received from E. H. Stewart, Wesix Electric Heater Co., who refers to the item on Electric Baseboard Panels in the February issue. He is naturally disappointed that his company is left out as one who makes what is called Automatic Wired Heat. The omission was unintentional. It is not possible to know all manufacturers of each device mentioned, nor was it desired, in this article, to cover too broad a field. However, I hereby make amends by offering in substance his letter, claims and some desirable features of a panel, as follows:

"It appears from your manufacturers' list that perhaps you intended to confine attention to the radiant glass type of baseboard, but I feel that this was not made clear. With this exception, I thought the article was excellent.



YES—and well he should be—because he has found out that Steam-Pak Generators really operate automatically, are fast heating, and save many dollars in fuel cost. But to him, one of the biggest factors is their cleanliness. These are just a few of the features. Write us for more details.



Steam-Pak Generators are built in a full range of sizes from 15 to 250 hp. for high or low pressure steam or hot water and can be fired with No. 3, 5, or 6 fuel oil or gas or a combination of both.

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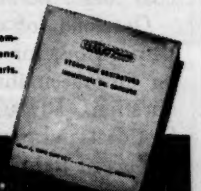
Steam-Pak's 208-page Architects' Manual is the only complete reference on steam generators. Contains specifications, hook-ups, wiring and piping diagrams, operating charts. Request Manual 101-C today on your letterhead.



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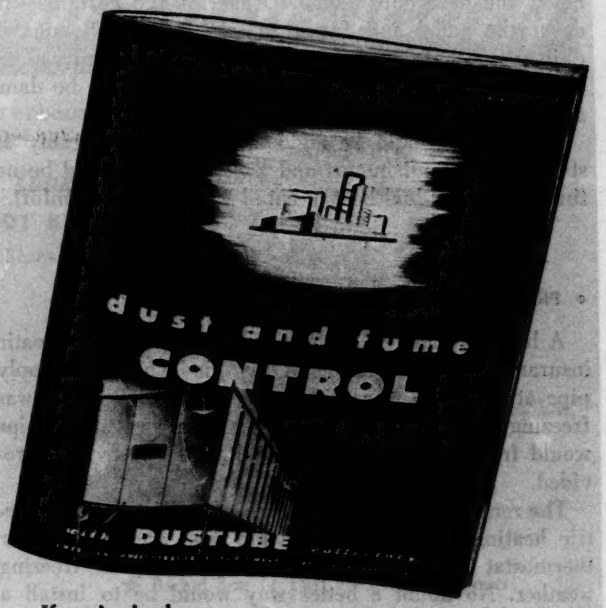

If you're in the habit of working with dust and fume problems, you will find the new Dustube Catalog a source of helpful information. It contains practical charts and useful tables designed to help you save time and effort in engineering dust and fume control systems. It explains how Dustube Collectors combine the proved efficiency of cloth filtration with a unique operating simplicity and economy. It describes the various types of Dustube Collectors and provides detailed information on each.

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"Any unit should be rigid and strong, preferably of steel to withstand bumps and kicks. There should be no time lag or residual heat to entail waste and discomfort."

• PROBLEM OF EXPOSED WATER LINE

A home owner in Mt. Kisco, N. Y. wanted automatic insurance against freezing of his one-inch water supply pipe at the point where it crossed a creek. When it was freezing weather, and the owner was away, this pipe would freeze up, were not some kind of protection provided.

The remedy was simple enough. It consisted of an electric heating cable attached to the pipe, and an outdoor thermostat for switching on the electricity in freezing weather. No doubt a better way would be to install a motorized valve in the pipe. Such a valve, in weather of about 32F, would open slightly by thermostatic control to waste a small amount of water at the end of the line to some indoor plumbing fixture.

• RELIEF VALVES DO NOT PREVENT WATER HAMMER

A reader states that his domestic hot water is heated by a coil in his furnace and that he recently installed a relief valve connected to a fitting on the top of the hot water tank in the hope this would relieve water hammer when water is used from faucets on the second floor. The relief valve is installed in a horizontal position due to lack of space. He questions this position. He also wants to know whether covering would reduce the noise.

Relief valves are usually of the horizontal type, but regardless of type, its operating mechanism should be installed vertically to prevent sediment affecting its relief action. Relief valves ease the excess pressure due to water expansion from heat. However, their operation is not quick enough to stop water hammer which may occur in the split part of a second. Many relief valve users do not appreciate this fact.

Repeated water hammer is likely to burst the tank. Covering will not reduce the noise, but the slow closing type faucet and faucets that are slowly closed at the final effective point of closure will help. A remedy can be applied that will eliminate the difficulty for a long time, depending upon how well designed and how well air chambers are installed at fixtures. Drain the system so that the air chambers will be renewed with air. Possibly there are no air chambers. Then a shock absorber should be installed on the main and preferably at the offending fixtures. Even where there are air chambers, shock absorbers are often the only relief. There are several types on the market, such as the units made by Wade, Mar-Coil and General Fittings.

• PIPING TO SPARE

During World War II a certain industrial plant obtained much needed but scarce pipe by removing all piping either no longer used or used as auxiliary steam piping runs paralleling main runs. Increase in pressure drop by passing all steam through the main runs was nearly offset by the eliminated friction and pressure drop through the tangled network of piping that was removed.

As the years go by, and depending upon how well the original piping system was laid out, there is always a tendency to extend some small pipe for a particular service rather than extend or increase the size of the large mains. So in time there is a lot of overhead pipe to confuse, collect dust, obscure light, leak, maintain, paint, overheat, lose heat and add to the pick-up load. Dead-end pipes also lose heat because their controlling valve may be negligently left open, or may be shut and leaking.

An element of unnecessary pressure drop and first cost is also due to the haphazard way in which pipes are often run. Too many elbows and fittings are used, of which many could be avoided were vertical pipes fitted close to walls, and horizontal pipes run about one foot away from the wall. Pipes close to a wall result in greater useable floor space. Pipes intermittently used should be sized small if the allowable pressure drop permits. This will give less thermal and pick-up losses.

• ESTIMATES SELDOM TELL THE COMPLETE STORY

According to an estimate, a contemplated boiler change should cost $10,000, take one year to effect and save $2,000 in the cost of coal used per year. To the first cost only, because one cannot think of everything, the estimator adds 10% for engineering contingencies. This he thinks will also cover things he knows about as possibilities, but which may or may not happen. What happens? The change costs $15,000, takes two years to complete, and saves $3,000 per year when a lot of indirect things are included which he had never thought about.

What are some of these things which he never thought about? Well, there is obviously less coal and ash handling if less coal is used. Then, too, if the boiler load has been reduced by the change, there will be less boiler and plant maintenance, less water used and less to soften. Possibly the plant can now be operated without overload and at greater efficiency and with less load, a cheaper grade of coal might be substituted.

Overload, of course, requires more supervision. But why go on, for savings may extend in many directions on unforseen things peculiar to the particular plant in question. To sum up, we are prone to underestimate first cost and time of completion and this serves to obtain the green light for proceeding on the undertaking. The pressure for an executive's favorable decision would be much greater were the element of savings fully explored and presented.

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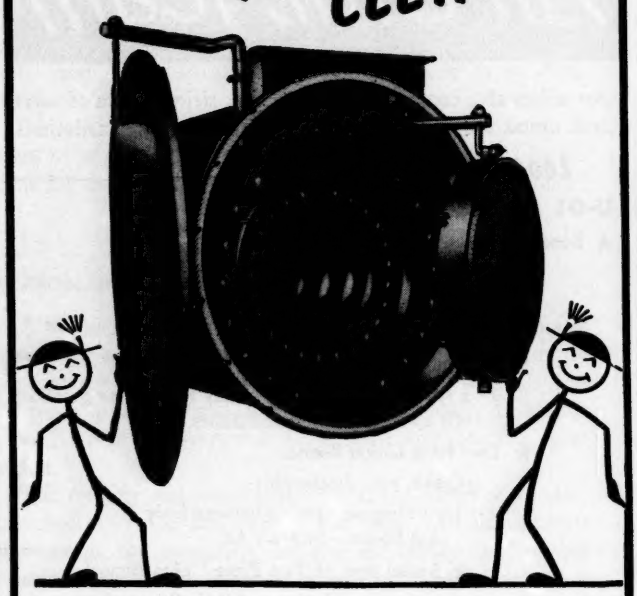

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ABSTRACTS AND REVIEWS

Publications abstracted in this department should be ordered direct from publisher.

HOT WATER SUPPLY

This pocket-size book was written by William Hutton, plumbing and heating contractor and Wendell M. Dillon, director of engineering, the Watts Regulator Co., Lawrence, Mass. It is intended to provide the plumber, supplier salesman or manufacturer salesman with all the information they may need on the subject of hot water supply. The material covers residential, commercial and industrial installation and maintenance.

The heaters described and illustrated have been selected as types currently available. The authors review some of the principles that enter into the construction and performance of water heaters and distributing systems. Information is supplied on the important subject of safety and control devices.

Hot Water Supply, by W. Hutton and W. M. Dillon. Cloth bound, 5 x 7¼ inches, 120 pages. Published by Scott-Choate Publishing Co., Inc., 45 W. 45th St. New York 19, N. Y. Price, $3.

MARINE AIR CONDITIONING AND REFRIGERATION

Modern Marine Refrigeration was first published in 1941. This volume, an enlargement of the earlier book, was prepared to fill a need of operating personnel aboard ships in the merchant marine. The author is Earl S. Shulters, construction representative, U. S. Maritime Administration.

Not only does this book contain enough theory to make the operation of refrigeration understandable, but it also devotes considerable space to the description of various types of systems that one may find aboard ship. Information is given on how to charge the system, test for leaks, and on the general but important subjects of operation and maintenance. At the end of each chapter are many review questions. Included with the book is a large folded Carrier psychrometric chart.

Some of the chapters are devoted to living accommodations, conditioning, general cargo hold conditioning, Cargocaire silica gel plant, Kathabar plant, ship's service stores refrigeration, cargo refrigeration, Freon refrigeration plants, ammonia refrigeration plant, and insulation. An appendix contains important related engineering data.

Marine Air Conditioning and Refrigeration, by E. S. Shulters. Cloth bound, 5¼ x 8¼ inches, 384 pages. Published by Cornell Maritime Press, Cambridge, Md. Price, $6.00.

• • •

I-B-R Ratings for Boilers and Baseboards—The Institute of Boiler and Radiator Manufacturers has issued a booklet on I-B-R ratings for cast iron boilers and for baseboards of all types. This is the first time that the approved I-B-R ratings for baseboards are combined with I-B-R ratings for boilers in one booklet. It should prove of interest to those concerned with the specification, design, sale or installation of hot water and steam heating systems. Institute of Boiler and Radiator Manufacturers, 60 East 42nd St., New York 17, N. Y. Price, 75 cents.

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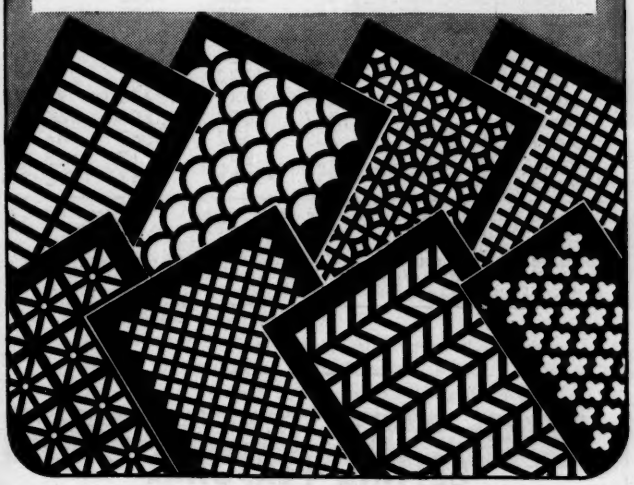

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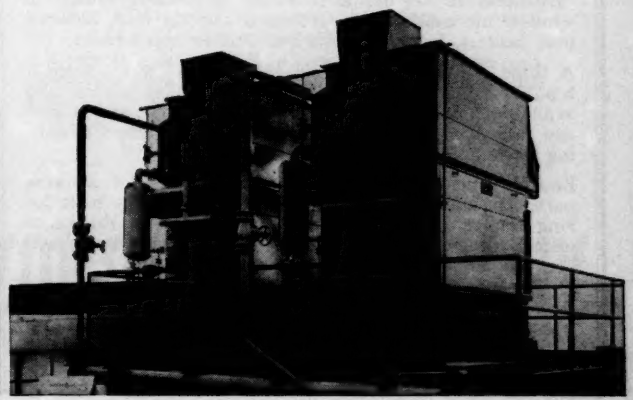

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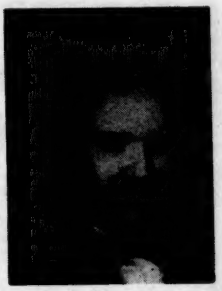
City	March 1952	March Normal	Cumulative Sept. 1 to Mar. 31 1951-52	Cumulative Sept. 1 to Mar. 31 Normal
Calgary, Alta.	1432	1215	8982	7881
Charlottetown, P. E. I.	1178	1203	6617	6869
Crescent Valley, B. C.	963	961	6795	6704
Edmonton, Alta.	1450	1290	9631	8589
Fort William, Ont.	1401	1386	8938	8590
Grande Prairie, Alta.	1463	1339	10015	8795
Halifax, N. S.	1023	1066	5571	6134
London, Ont.	1048	1073	6347	6326
Medicine Hat, Alta.	1398	1150	8547	7588
Moncton, N. B.	1179	1190	6907	7296
Montreal, P. Q.	1125	1265	6990	7373
North Bay, Ont.	1364	1280	8299	7933
Ottawa, Ont.	1181	1256	7339	7638
Penticton, B. C.	812	787	5948	5566
Porquis Junction, Ont.	1507	1550	9635	9614
Prince George, B. C.	1178	738	8603	8506
Quebec City, P. Q.	1147	1311	7372	7999
Regina, Sask.	1606	1504	10094	9641
St. John, N. B.	1045	1132	6247	6784
Saskatoon, Sask.	1624	1445	10475	9356
Toronto, Ont.	1017	1072	5803	6226
Vancouver, B. C.	709	682	4669	4479
Windsor, Ont.	958	995	5717	5872
Winnipeg, Man.	1420	1531	9441	9622

*These data are supplied through the courtesy of the Meteorological Division, Air Service Branch, Department of Transport, Canada.
The Department reports slight revisions in the figure for February, as published in last month's issue. Corrected figures are: Crescent Valley, B. C., 1038; Medicine Hat, Alta., 1314; Regina, Sask., 1596; Vancouver, B. C., 727.

GETTING PERSONAL



W. H. Reynolds

William H. Reynolds *(Window Defrosting System for an Automobile Showroom*, page 81) specialized in heating, ventilating and air conditioning and received his BSME degree from Purdue University in 1938.

For a period of about ten years he was employed by Shell Oil, Pure Oil, Standard of Ohio and Sinclair Oil in various phases of mechanical engineering as it applied to the petroleum refining industry. He was chief of the Maintenance Control Division of Standard of Ohio and instrumental in the organization of this division of the manufacturing department.

Mr. Reynolds served in the U. S. Navy for two years as junior officer on the submarine USS Sablefish.

Since 1949 he has been a mechanical engineer consultant with Battey & Childs, engineers-architects, Chicago, and also in Gary, Ind.

Jerome M. Morse *(Charts to Check Operation of Refrigeration Plants, page* 79) has been active in the refrigeration and air conditioning fields since 1929. He has been in the employ of Carrier Corp., and also some of that company's distributors, and has been associated with a distributor for Worthington Pump and Machinery Corp. During World War II, he was aboard a U. S. Navy cargo ship and served on an APA as a

(*Concluded on page* 140)

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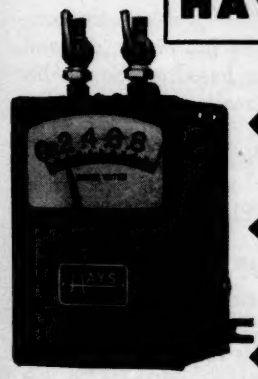

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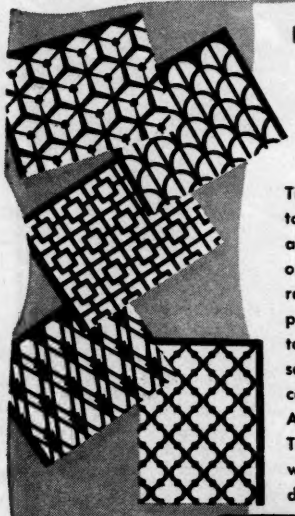

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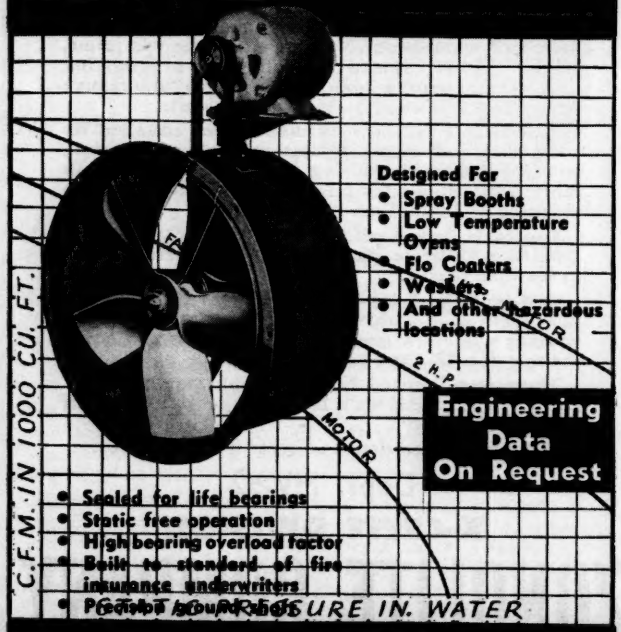

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(*Concluded from page* 138)

refrigeration specialist. For the past five years he has been with Wolff & Munier, Inc., as a refrigeration supervisor.

The charts were developed during the installation of twelve 40 hp refrigeration plants for a large research laboratory, when a need for such data developed.

Mr. Morse is a member of the ASRE and the ASHVE.

J. E. Ziegler

John E. Ziegler *(Snow Melting System Design for a Shipping Center, page* 83) is a research associate in the Research Department of Revere Copper and Brass Incorporated, Rome, N. Y. An M. E. graduate of Clarkson College of Technology, for the past four years he has been engaged in research and development work in the fields of heat transfer, radiant heating, and snow melting systems.

Mr. Ziegler is the co-author of a booklet on residential radiant heating which covers design, installation and operation. He has assisted in the preparation of other technical material.

WHAT READERS SAY

Hot Water Demand

EDITOR, HEATING AND VENTILATING:

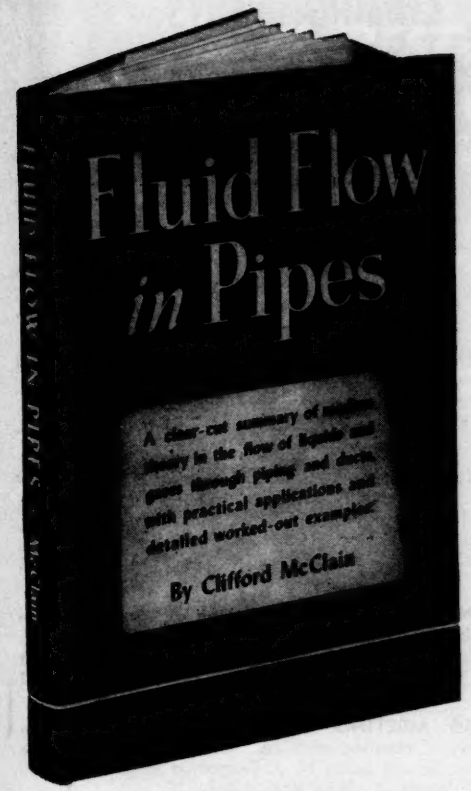
Being a comparatively newcomer in the field of plumbing for industrial plants, I was very happy to read J. E. York's article, Water and Plumbing Systems for a Modern Industrial Plant, in the March and April, 1952 issues of HEATING AND VENTILATING.

Although I found the article very interesting and informative, I could not agree with Mr. York's approach to the hot water demand aspect of the problem. Concerning the method of determining the hot water demand, I feel the the calculations should be based on the number of persons using the facilities. I realize that this information is not always available to the designer and in these cases there is no other choice but to follow a method similar to that used by Mr. York. However, when such information may be obtained, I believe it should be used.

Regardless of the method used in determining the amount of hot water required, I cannot agree with Mr. York's choice of the heating coil (recovery rate). In his example, 405 gal of hot water is required. A 370 gal capacity tank will supply only about 280 gal of hot water before the incoming cold water excessively cools the hot water stored. Therefore, the heating element must be sized to heat the 125 gal of additional hot water within the 20-minute peak period. This requires a recovery rate of 125/20 = 6.3 gpm or 380 gph. Mr. York's choice of a 370 gal storage tank with a 200 gph heating coil will not supply the required 405 gal in the 20-minute period.

Howard S. Molk
Mechanical Designer,
Gibbs and Hill, Inc.

New York, N. Y.



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FLUID FLOW IN PIPES shows how to handle viscosity, friction, turbulence, head and other factors, and illustrates the over-all influence of each. The author gives particular attention to the theory, measurement and dimensions of viscosity, and the units of evaluation are carefully explained.

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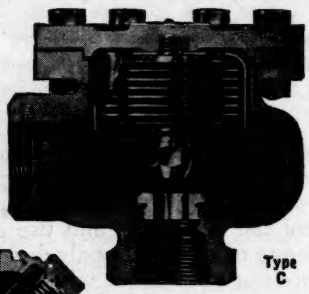

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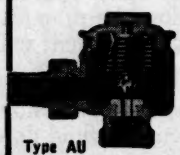

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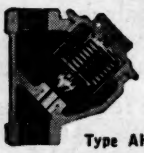

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COMING EVENTS

Where listed, names or titles of individuals are those from whom further information is available.

GAS APPLIANCE MEETING—Annual meeting of the Gas Appliance Manufacturers Association at The Broadmoor, Colorado Springs, Colo. H. Leigh Whitelaw, managing director, 60 E. 42nd St., New York, N. Y. .....**MAY 21-23, 1952.**

ASRE SPRING MEETING—39th spring meeting of the American Society of Refrigerating Engineers at the Atlanta Biltmore Hotel, Atlanta, Ga. Secretary, M. C. Turpin, 40 W. 40th St., New York 18, N. Y. .....**JUNE 1-4, 1952.**

NDHA MEETING—Annual meeting of the National District Heating Association at Skytop Lodge, Skytop, Pa. John F. Collins, secretary of the Association, 827 N. Euclid Ave., Pittsburgh 6, Pa. ..... **JUNE 3-6, 1952.**

CONTRACTORS CONVENTION—63rd annual convention of the Heating, Piping and Air Conditioning Contractors National Association at the Statler Hotel, Boston, Mass. Joseph C. Fitts, secretary of the Association, 1250 Avenue of the Americas, New York 20, N. Y. .....**JUNE 10-13, 1952.**

ASME MEETING — Semi-annual meeting of the American Society of Mechanical Engineers, at the Sheraton Gibson Hotel, Cincinnati, Ohio. C. E. Davies, secretary of the Society, 29 West 39th St., New York, N. Y. ..... **JUNE 15-19, 1952**

ASHVE SPRING MEETING—Semi-annual meeting of the American Society of Heating and Ventilating Engineers at The Essex and Sussex, Spring Lake, N. J. Executive Secretary, A. V. Hutchinson, 62 Worth St., New York 13, N. Y.
JUNE 16-18, 1952.

STOKER MEETING—1952 annual meeting of the Stoker Manufacturers Association, at the South Shore Inn on Lake Wawasee near Syracuse, Indiana. Marc G. Bluth, executive secretary of the Association, 307 No. Michigan Ave., Chicago 1, Ill. .....**JUNE 22-24, 1952.**

TESTING MATERIALS MEETING—Annual meeting of the American Society for Testing Materials at the Hotel Statler, New York, N. Y. Secretary of the Society, 1916 Race St., Philadelphia 3, Pa. .....**JUNE 23-27, 1952.**

ELECTRICAL ENGINEERS MEETING—Summer general meeting of the American Institute of Electrical Engineers, at the Nicollet Hotel, Minneapolis, Minn. Secretary of the Institute, 33 West 39th St., New York 18, N. Y. ..**JUNE 23-27, 1952.**

ASME MEETING—Fall meeting of the American Society of Mechanical Engineers, at the Sheraton Hotel, Chicago, Ill. C. E. Davies, secretary of the Society, 29 West 39th St., New York, N. Y. .....**SEPTEMBER 8-11, 1952.**

INSTRUMENT CONFERENCE AND EXHIBIT—Seventh National Instrument conference and exhibit, in Cleveland, Ohio. John McCaffery, assistant executive secretary of the Society, 1319 Allegheny Ave., Pittsburgh 33, Pa.
SEPTEMBER 8-12, 1952

AGA CONVENTION—Annual convention of the American Gas Association, in the Auditorium, Atlantic City, New Jersey. Secretary of the Association, 420 Lexington Avenue, New York, N. Y. .....**WEEK OF OCTOBER 27, 1952.**

ASA MEETING—34th annual meeting of the American Standards Association, at the Waldorf Astoria Hotel, New York, N. Y. Secretary of the Association, 70 E. 45th St., New York.
NOVEMBER 19, 1952

ASME MEETING—Annual meeting of the American Society of Mechanical Engineers, at the Hotel Statler, New York, N. Y. C. E. Davies, secretary of the Society, 29 West 39th St., New York, N. Y....**NOVEMBER 30-DECEMBER 5, 1952**

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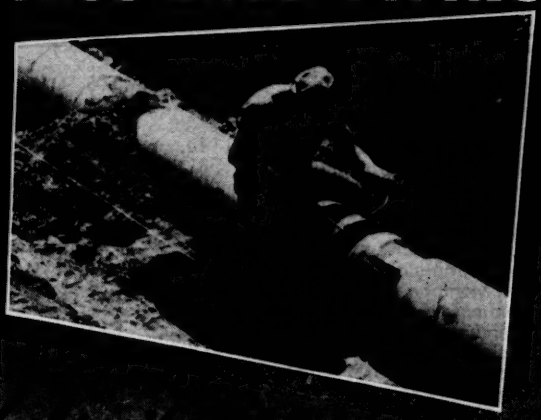

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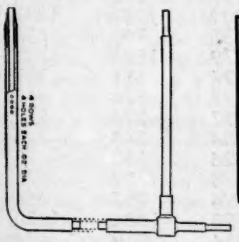
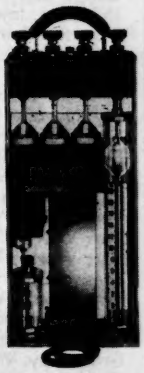


Be Sure with ELLISON Instruments



Pitot Tubes for air and gas flow measurements. Angle and straight stem types, brass for temperatures to 500°F., stainless steel for temperatures to 1000°F. Bulletin 109.

PORTABLE GAS ANALYZERS Accurate, easy to use Combustion Testing Set equipped for analysis of CO_2, O_2 and CO, complete with flue gas thermometer. Bulletin 120.

ELLISON DRAFT GAGE CO.

210 W. KINZIE ST. Since 1896. CHICAGO 10, ILL.

THE ELLISON LINE ALSO INCLUDES:

Dial Draft Gages—Bell Type · Inclined Draft Gages—Portable Inclined Vertical Tube Gages · Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube · Saturator Gages U Gages—Stationary and Portable · Air Filter Gages—Dial and Inclined Tube Types · Pitot Tubes · U Path Steam Calorimeters Portable Gas Analyzers—Orsat Type

COOLING TOWER by KRAMER

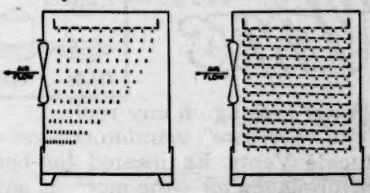
3 to 8 Ton

SCIENTIFIC NEW FILL

MORE CAPACITY
The redistributing decks keep the water uniformly suspended, providing maximum contact between air and water.

LONG LIFE
Casing and sump are heavy gauge steel, hot dipped galvanized after fabrication. Redistributing decks are metal and fireproof.

EASY INSTALLATION
Unit is shipped assembled but can be knocked down to eliminate rigging costs. One fitting required for drain and over-flow.

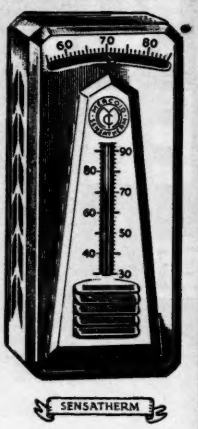


Conventional Fill Kramer Fill

Write for Catalog R-225

KRAMER TRENTON CO.

Trenton 5, N.J.



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THEY ASSURE HOME OWNER SATISFACTION

THE MERITS OF MERCOID CONTROLS ARE WELL ESTABLISHED

MERCOID-1ST-IN QUALITY AND RELIABLE PERFORMANCE

THEY ARE BY FAR THE BEST CONTROL BUY ANYWHERE TODAY

WRITE FOR CATALOG Nº 700A

THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILL.

MEET THE NEW MODEL

MUCKLE VENTS

Take a look at the new silhouette ... its low slung and streamlined—better looking on any roof!

Get away from old, "eye sore" ventilators—get the newly designed Muckle Vents. Engineered for better performance in moisture-laden air—the motor is out of line of air flow. A compact, good looking, easy to install all-in-one unit to fit any roof.

Some territories open for sales representatives

Write today for more information on Muckle Vents.

Muckle MANUFACTURING CO.
OWATONNA 3, MINN.

DEGREE-DAYS FOR MARCH, 1952

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city.

HEATING AND VENTILATING'S 24th Year of Publication of Monthly Degree-Day Data

City	March		
	1952	1951	Normal
Abilene, Texas (A)	342	297	273
Albany, New York (A)	1000	916	980
Albuquerque, New Mexico (A)	693	572	527
Alpena, Michigan (C)	1163	1107	1213
Anaconda, Montana (C)	1194	1224	1081
Asheville, North Carolina (C)	582	538	555
Atlanta, Georgia (C)	409	373	388
Atlantic City, New Jersey (C)	740	698	806
Augusta, Georgia (A)	321	291	273
Baker, Oregon (C)	967	989	880
Baltimore, Maryland (C)	667	611	701
Billings, Montana (A)	1021	1313	955
Binghamton, New York (C)	935	909	995
Birmingham, Alabama (A)	388	326	260
Bismarck, North Dakota (A)	1472	1680	1283
Block Island, Rhode Island (A)	844	813	911
Boise, Idaho (A)	868	860	651
Boston, Massachusetts (A)	856	797	908
Bozeman, Montana (C)	1217	1288	1096
Buffalo, New York (A)	968	917	1032
Burlington, Iowa (A)	932	1019	(a)
Burlington, Vermont (A)	1082	1000	1088
Butte, Montana (C)	1281	1271	1048
Cairo, Illinois (C)	520	539	539
Charleston, South Carolina (C)	215	232	242
Charlotte, North Carolina (C)	440	395	428
Chattanooga, Tennessee (A)	454	408	415
Cheyenne, Wyoming (A)	1141	1103	995
Chicago, Illinois (C)	904	907	845
Cincinnati, Ohio (C)	620	665	676
Cleveland, Ohio (A)	870	828	930
Columbia, Missouri (A)	746	812	694
Columbia, South Carolina (C)	302	296	301
Columbus, Ohio (C)	742	734	778
Concord, New Hampshire (A)	1021	971	1011
Concordia, Kansas (C)	885	893	735
Dallas, Texas (A)	314	260	267
Davenport, Iowa (C)	936	1011	893
Dayton, Ohio (A)	785	816	744
Deer Lodge, Montana (C)	1164	1136	1056
Denver, Colorado (C)	962	898	800
Des Moines, Iowa (A)	975	1122	890
Detroit, Michigan (A)	945	878	973
Devils Lake, North Dakota (C)	1405	1641	1323
Dodge City, Kansas (A)	819	808	688
Dubuque, Iowa (C)	1087	1168	958
Duluth, Minnesota (C)	1286	1401	1265
Eastport, Maine (A)	1021	990	1232
Elkins, West Virginia (A)	817	779	763
El Paso, Texas (A)	437	322	282
Ely, Nevada (A)	1312	1008	(a)
Erie, Pennsylvania (C)	907	843	973
Escanaba, Michigan (C)	1202	1189	1262
Evansville, Indiana (A)	635	700	620
Fargo, North Dakota	1379	1523	1225
Fort Smith, Arkansas (A)	477	454	397
Fort Wayne, Indiana (A)	877	874	818
Fort Worth, Texas (A)	317	276	217
Fresno, California (A)	454	348	316
Galveston, Texas (C)	126	118	78
Grand Junction, Colorado (A)	878	739	672
Grand Rapids, Michigan (A)	994	957	964
Green Bay, Wisconsin (C)	1183	1184	1125
Greensboro, North Carolina (A)	534	519	474
Greenville, South Carolina (A)	430	410	446
Harrisburg, Pennsylvania (A)	791	742	803
Hartford, Connecticut (A)	854	801	887
Hatteras, North Carolina (C)	440	416	465
Havre, Montana (C)	1376	1498	1169
Helena, Montana (A)	1161	1356	1004
Houston, Texas (C)	147	119	65
Huron, South Dakota (A)	1322	1415	7167
Indianapolis, Indiana (A)	774	837	756
Jackson, Mississippi (A)	298	242	(a)
Kansas City, Missouri (A)	781	803	691
Knoxville, Tennessee (A)	487	471	496
La Crosse, Wisconsin (A)	1067	1237	1033
Lander, Wyoming (A)	1176	1082	1028

(a) Data not available.

City	March		
	1952	1951	Normal
Lansing, Michigan (A)	1025	960	1035
Lewiston, Maine (O)	967	971	1093
Lincoln, Nebraska (C)	952	991	840
Little Rock, Arkansas (A)	434	392	353
Livingston, Montana (C)	935	1180	967
Los Angeles, California (C)	310	168	239
Louisville, Kentucky (A)	603	674	589
Lynchburg, Virginia (A)	602	600	564
Macon, Georgia (A)	259	254	260
Madison, Wisconsin (C)	1091	1137	1054
Marquette, Michigan (C)	1184	1213	1249
Memphis, Tennessee (A)	454	400	384
Meridian, Mississippi (A)	334	249	245
Milwaukee, Wisconsin (A)	1043	1052	1023
Minneapolis, Minnesota (A)	1199	1353	1094
Moline, Illinois (A)	970	1020	(a)
Montgomery, Alabama (A)	285	244	208
Nantucket, Massachusetts (A)	888	808	899
Nashville, Tennessee (A)	514	483	477
New Haven, Connecticut (A)	852	794	899
New Orleans, Louisiana (C)	125	130	59
New York, New York (C)	766	721	771
Nome, Alaska† (A)	(a)	1994	1756
Norfolk, Virginia (C)	504	494	521
North Head, Washington (C)	670	720	623
North Platte, Nebraska (A)	1051	1028	875
Oakland, California (C)	429	360	363
Oklahoma City, Oklahoma (C)	539	507	465
Omaha, Nebraska (A)	972	1055	868
Oswego, New York (C)	984	916	1060
Parkersburg, West Virginia (C)	677	647	670
Peoria, Illinois (A)	891	931	862
Philadelphia, Pennsylvania (C)	715	667	685
Phoenix, Arizona (C)	288	129	152
Pittsburgh, Pennsylvania (C)	751	713	787
Pocatello, Idaho (A)	1111	980	843
Portland, Maine (A)	1023	976	1017
Portland, Oregon (C)	582	669	558
Providence, Rhode Island (C)	832	758	890
Pueblo, Colorado (A)	840	830	732
Raleigh, North Carolina (C)	468	436	446
Rapid City, South Dakota (A)	1208	1245	1010
Reading, Pennsylvania (C)	751	711	794
Red Bluff, California (A)	461	332	(a)
Reno, Nevada (A)	955	818	753
Richmond, Virginia (C)	551	543	543
Rochester, New York (A)	976	908	1029
Roswell, New Mexico (A)	512	466	428
Sacramento, California (C)	432	326	357
St. Joseph, Missouri (A)	835	893	682
St. Louis, Missouri (C)	693	741	657
Salt Lake City, Utah (A)	971	861	722
San Antonio, Texas (A)	157	148	74
San Diego, California (A)	280	191	251
Sandusky, Ohio (C)	861	811	915
San Francisco, California (C)	420	330	353
Sault Ste. Marie, Michigan (A)	1279	1207	1314
Savannah, Georgia (A)	200	223	167
Scranton, Pennsylvania (C)	881	835	893
Seattle, Washington (C)	589	686	620
Sheridan, Wyoming (A)	1193	1211	1048
Shreveport, Louisiana (A)	308	246	202
Sioux City, Iowa (A)	1083	1197	967
Spokane, Washington (A)	867	944	778
Springfield, Illinois (C)	784	841	760
Springfield, Missouri (A)	663	687	626
Syracuse, New York (A)	978	921	1004
Tacoma, Washington (C)	647	740	648
Terre Haute, Indiana (A)	746	814	663
Toledo, Ohio (A)	897	877	905
Topeka, Kansas (C)	803	827	682
Trenton, New Jersey (C)	767	715	735
Utica, New York (O)	1018	961	989
Valentine, Nebraska (C)	1169	1236	980
Walla Walla, Washington (C)	606	694	548
Washington, D. C. (C)	656	598	694
Wichita, Kansas (A)	747	772	648
Williston, North Dakota (C)	1453	1680	1280
Winnemucca, Nevada (C)	1000	894	767
Yakima, Washington (A)	740	834	620

(a) Data not available. †Nome data are for February.

Figures in this table, with seven exceptions, based on local weather bureau reports. Exceptions are Utica and Lewiston, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y., and Norman R. Rose, Bureau, Bates College, Lewiston, Me., respectively; Anaconda, Bozeman, Butte, Deer Lodge and Livingston, Mont., through the courtesy of the Montana Power Company.

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Low Return Connection
Low Speed, Long Life
Cast Iron Receiver
Low Water Line
Single or Duplex

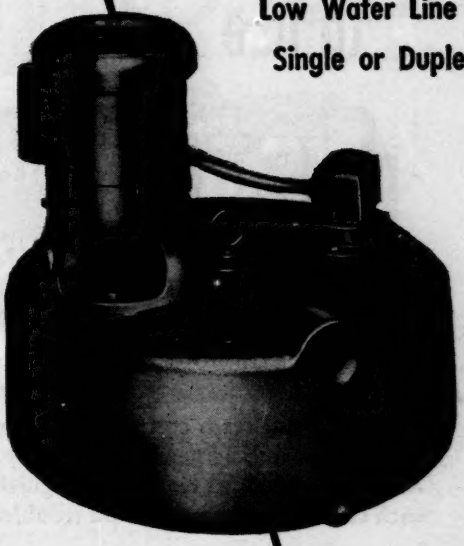

Fig. TVC 118
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Capacities from
500 to 10,000 Sq. Ft. E.D.R.

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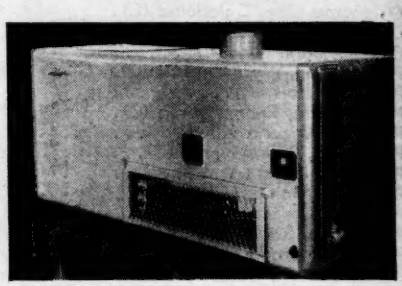
1. Sicon Protects Gas Heater Combustion Chambers at 875°

2. Sicon in COLORS Preserves Appearance of Heating Equipment Indefinitely



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For Accurate Measurement of Air Velocity and Air Pressure

Low Velocity Range: 0-750 fpm
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Pressure Range: 0-4 inches water

Based on the hot thermopile principle, the AGITAIR Meter gives instantaneous accurate measurements of air velocities as low as 5 fpm, and as high as 5500 fpm. It is inherently stable, does not waver or jerk and unlike many resistance type hot-wire instruments it is free from errors caused by temperature variations, radiation effects and lead resistance. For taking static pressure readings from 0 to 4" wg, a special attachment is provided. The simplicity and utility of the AGITAIR Meter make it useful for many diverse applications. 50-1

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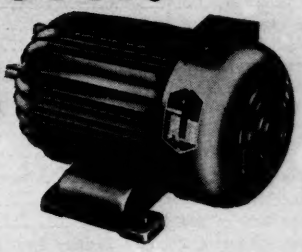
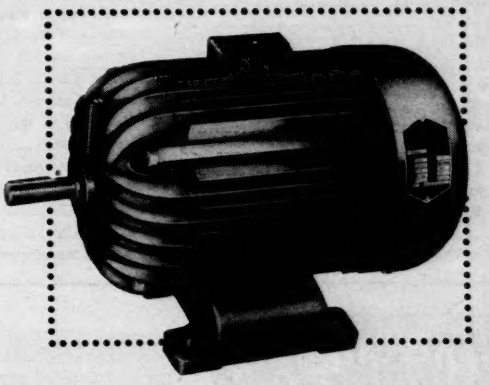
Air Diffusers • Air Filters • Exhausters

New Hoover® Motors totally enclosed





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And you are getting more for your money than with any comparable motor on the market.

There are both *self-cooled* and *fan-cooled* models—newly designed to keep trouble out and performance high. No openings to let moisture in. No blind passages to catch dust and dirt.

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Polyphase motors through 5 H. P. Capacitor start motors through 3 H. P. All built in NEMA frames. Extremely compact. More horsepower for each pound of motor—more motor for your money in every way.

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It's Something Special

The "Elgo" Automatic Shutter, because of its outstanding features, is really something special. It's noted not only for its quick-opening and tight-closing louvers but also for its quietness—never any blade flutter. Sizes from 12" to 72"—also rectangular.

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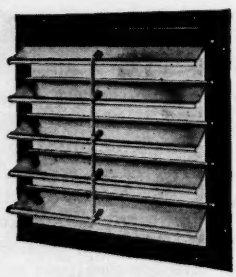

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Front View (Open)

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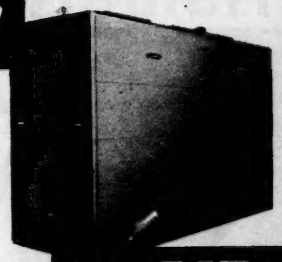
Refrigerated Kooler-aire with Heating Coil



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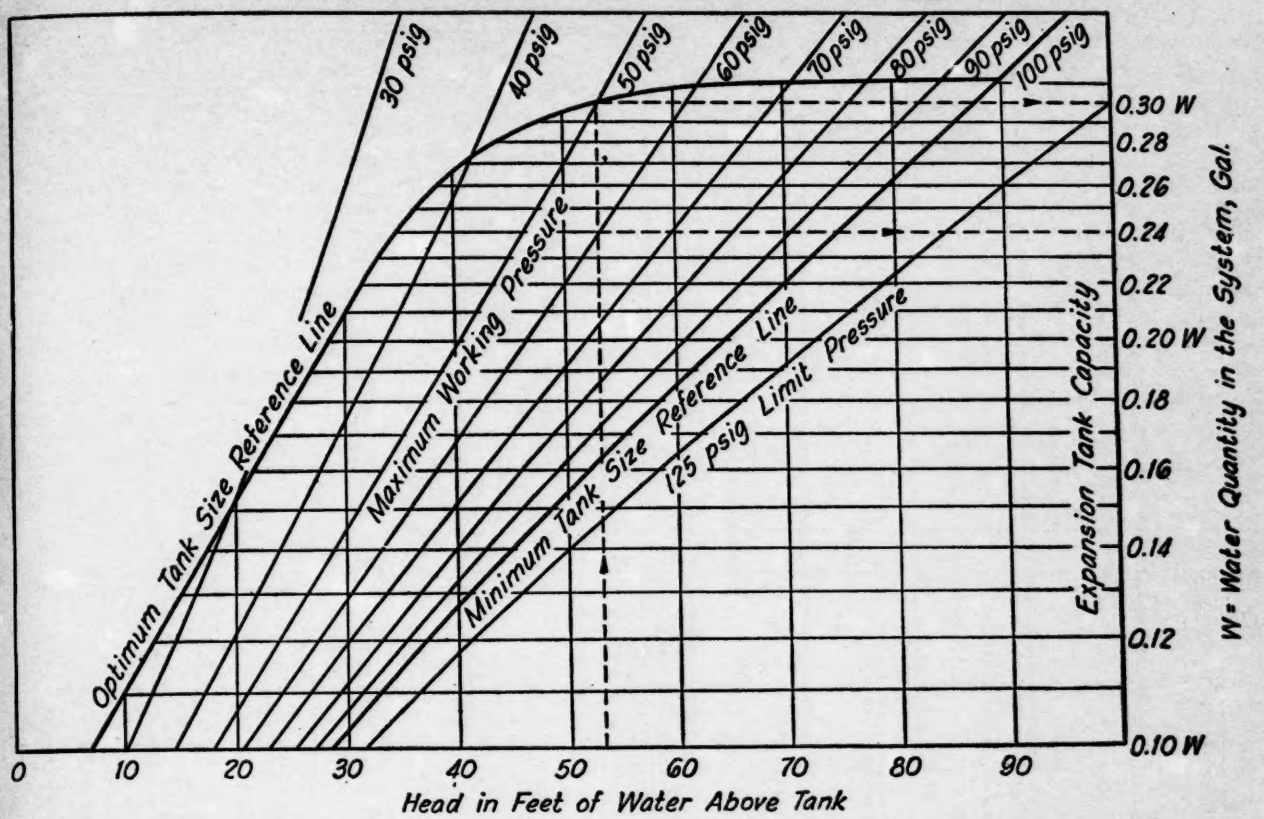
SIZING HOT WATER EXPANSION TANKS



The accompanying chart and explanation is abstracted from material prepared by George J. Jankauskas. Use of the chart is explained by the following examples.

Example. A hot water system has a head of 53 feet and a system water volume (W) of 1,000 gallons. What size expansion tank is to be used, what pressure will be developed in it, and what would be the minimum size tank that could be used?

Solution. From 53 on the horizontal scale move vertically to the optimum reference line, thence right and read 0.30W. Since 0.30W = 300 gallons, this is the recommended size tank. The intersection of the curve and the 53 line also shows the working pressure to be 50 pounds gage.

The minimum tank size is found to be 0.163W or 163 gallons, in which case the working pressure would be 100 pounds gage.

If a predetermined working pressure is selected, read to the right. For example, if 60 pounds pressure is desired, move up the 53 line to 60, thence right and read 0.24W, or 240 gallons as the tank capacity.

The safety valve pressure should be 10 pounds above the working pressure.

If the system is connected to the water supply by means of a self-filling pressure reducing valve, the reducing valve must be adjusted to the system's static pressure. If it is not, a higher working pressure will be developed in the system.

Example. What will be the working pressure in the given example with a tank size 0.3W, if the self-filling pressure reducing valve is adjusted to 30 pounds gage?

Solution. The system's effective static head will be:

$$H = \frac{30}{0.434} = 70 \text{ feet.}$$

With 70 feet of head and 0.3W tank capacity in the system, 71 psi gage pressure will be developed instead of 50 psi gage. This is shown by the intersection of vertical 70 feet head with the horizontal 0.3W.

It is well to bear in mind that the pressures given are maximum pressures developed by the expansion of a system, filled cold and then heated. Any method of filling or charging the system that provides for bleeding off the expanded volume of water will result in lower working pressures, to that limit established by the head of water in the system.

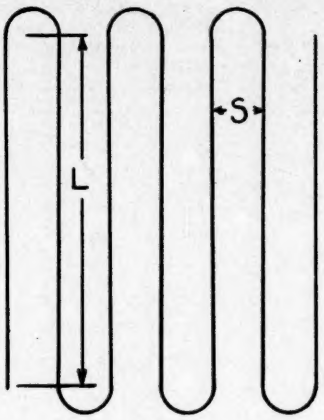
If the water in the expansion tank is drained in hot condition and the heating system switched off after that, the temperature of water falls, and the pressure in the system will also fall below system's static head. As a result, the radiators in the upper floors can remain without water. On heating, radiators will be again filled with water, if the system is air-tight.

The optimum tank size (volume) reference line is based on the volume of the tank capacity in gallons being equal to kW, where W is the water volume in the system in gallons, and k is 0.1 for a one-story building, and 0.13, 0.17 and 0.23 for 2, 3 and 4 story buildings, respectively.

PIPE REQUIRED FOR RADIANT HEAT COILS

The accompanying table has been designed to facilitate finding the linear feet of pipe required for panel heating coils of the type shown in the drawing, where *L* is the length of straight run, in feet, and *S* the spacing in inches between runs. The table gives the number of feet of pipe in the bends; to this is to be added the straight runs.

The table was developed by Robert K. Demarest, Jr., Columbia, S. C.

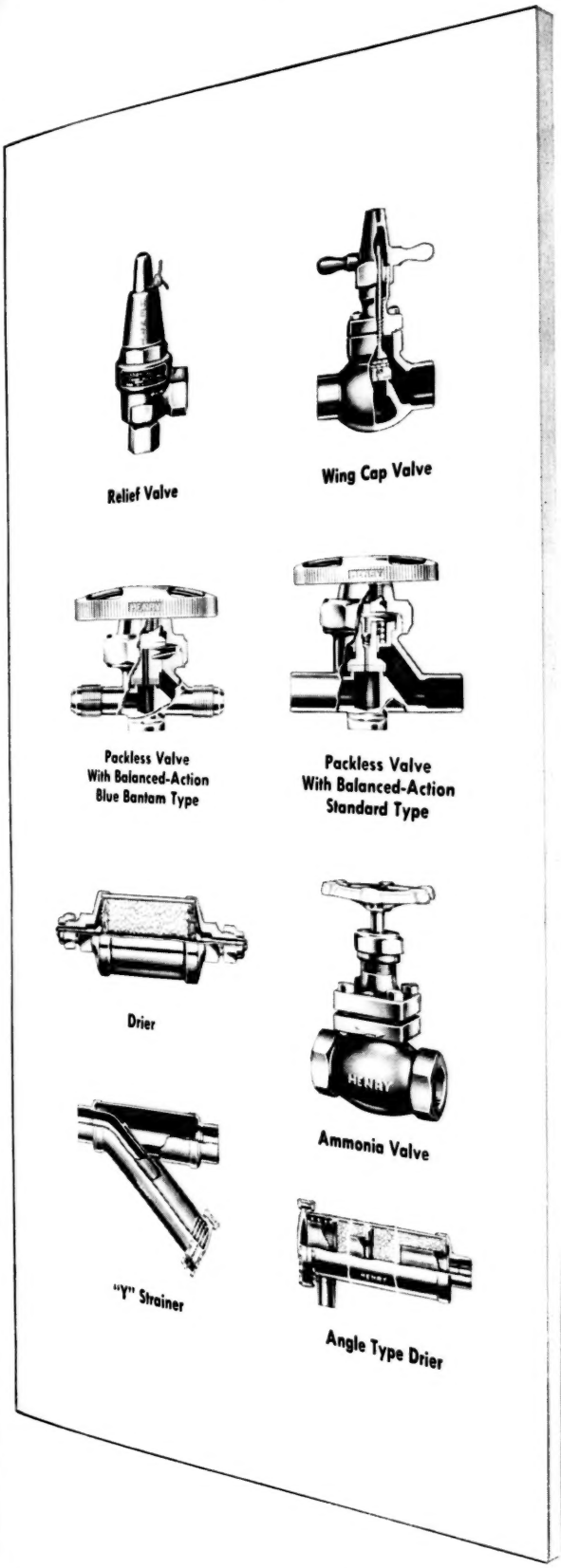


Problem. Assume a coil as shown in the drawing, *S* being 18 inches (center-to-center spacing) while *L*, the length of straight run, is 5 feet. How much pipe is required for the coil?

Solution. Count the number of bends (six) and the number of straight runs (seven). The straight pipe needed is then 7 x 5 feet or 35 feet. Refer to the table and under 6 (number of bends) and opposite 18 (inches spacing) find 14.18 lineal feet of pipe in the bends. Total pipe required is then 35 + 14.18 = 49.18 feet.

Pipe Spacing, S, Inches	Number of Bends									
	1	2	3	4	5	6	7	8	9	10
	Lineal Feet of Pipe in Bends									
6	0.785	1.57	2.35	3.14	3.93	4.71	5.50	6.28	7.06	7.85
8	1.047	2.09	3.14	4.19	5.23	6.28	7.33	8.38	9.42	10.47
9	1.18	2.36	3.54	4.72	5.90	7.08	8.25	9.44	10.61	11.80
10	1.31	2.62	3.93	5.24	6.55	7.86	9.17	10.48	11.80	13.10
11	1.44	2.88	4.32	5.76	7.20	8.64	10.08	11.51	12.95	14.40
12	1.57	3.14	4.71	6.28	7.85	9.42	11.00	12.56	14.13	15.70
13	1.70	3.40	5.10	6.80	8.50	10.20	11.95	13.60	15.30	17.00
14	1.83	3.66	5.50	7.32	9.15	11.00	12.80	14.63	16.43	18.30
15	1.96	3.92	5.88	7.84	9.80	11.73	13.70	15.65	17.63	19.60
16	2.09	4.18	6.27	8.36	10.42	12.50	14.60	16.70	18.80	20.90
17	2.22	4.44	6.66	8.88	11.10	13.35	15.55	17.75	20.00	22.20
18	2.36	4.72	7.08	9.44	11.80	14.18	16.50	18.90	21.23	23.60
19	2.49	4.96	7.47	9.96	12.41	14.60	17.40	19.40	22.40	24.90
20	2.62	5.24	7.86	10.48	13.12	15.75	18.40	21.00	23.60	26.20
21	2.74	5.48	8.22	10.96	13.70	16.42	19.20	21.90	24.65	27.40
22	2.88	5.76	8.66	11.55	14.40	17.30	20.20	23.10	26.00	28.80
23	3.01	6.02	9.03	12.02	15.03	18.10	21.10	24.10	27.10	30.10
24	3.14	6.28	9.42	12.56	15.70	18.80	21.95	25.15	28.20	31.40
25	3.28	6.56	9.84	13.12	16.40	19.70	23.00	26.25	29.50	32.80
26	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00

Pipe Spacing, S, Inches	Number of Bends									
	11	12	13	14	15	16	17	18	19	20
	Lineal Feet of Pipe in Bends									
6	8.64	9.42	10.20	11.00	11.78	12.55	13.35	14.13	14.90	15.70
8	11.50	12.57	13.60	14.60	15.70	16.74	17.80	18.85	19.89	20.94
9	12.97	14.15	15.32	16.50	17.70	18.88	20.03	21.10	22.40	23.60
10	14.40	15.70	17.01	18.34	19.65	20.95	22.25	23.55	24.90	26.20
11	15.85	17.28	18.72	20.15	21.60	23.00	24.50	25.96	27.35	28.80
12	17.30	18.82	20.40	22.00	23.50	25.10	26.70	28.25	29.80	31.40
13	18.70	20.40	22.10	23.80	25.50	27.20	28.90	30.60	32.30	34.00
14	20.15	22.00	23.75	25.60	27.50	29.25	31.11	33.00	34.80	36.50
15	21.50	23.50	25.50	27.45	29.40	31.35	33.25	35.25	37.20	39.15
16	23.00	25.00	27.20	29.20	31.25	33.40	35.50	37.50	39.65	41.75
17	24.45	26.60	29.85	31.10	33.35	35.55	37.75	40.00	42.20	44.40
18	26.00	28.30	30.65	33.00	35.45	37.75	40.10	42.50	44.80	47.20
19	27.35	29.85	32.25	34.80	37.25	39.75	42.30	44.75	47.35	49.65
20	28.80	31.50	34.10	36.70	39.35	42.00	44.60	47.20	49.80	52.40
21	30.15	32.80	35.60	38.40	41.10	43.85	46.60	49.30	52.00	54.80
22	31.70	34.60	37.50	40.40	43.20	46.15	49.00	51.90	54.85	57.80
23	33.15	36.15	39.10	42.15	45.20	48.15	51.20	54.20	57.20	60.20
24	34.50	37.60	40.75	44.00	47.00	50.10	53.25	56.50	59.60	62.80
25	36.10	39.45	42.70	46.00	49.25	52.60	55.85	59.10	62.40	65.60
26	37.45	40.85	44.20	47.60	51.00	54.50	57.90	61.30	64.60	68.00



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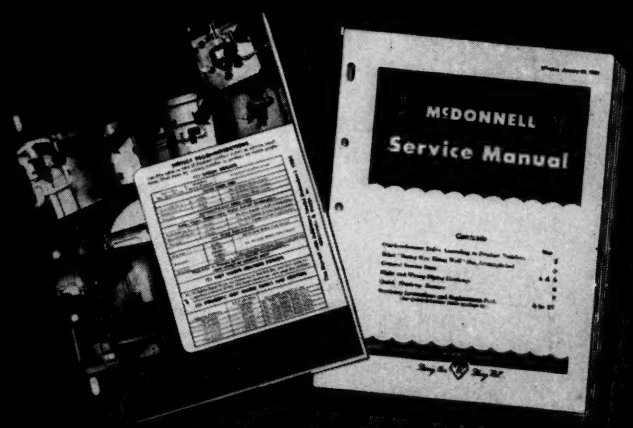

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